SCIENTIFIC AMERICAN SUPPLEMENT. No. 1192

Copyright, 1898, by Munn & Co.

Scientific American, established 1845.
Scientific American Supplement, Vol. XLVI, No. 1192. NEW YORK, NOVEMBER 5, 1898. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

EMPEROR WILLIAM II. IN THE UNIFORM DESIGNED BY HIMSELF FOR HIS JOURNEY TO PALESTINE.

EMPEROR WILLIAM II. IN THE UNIFORM DESIGNED FOR HIS JOURNEY TO PALESTINE.

SINCE so much has been said by the press about the German Emperor's journey to Palestine, we think our readers may be interested in the accompanying engraving and description (for which we are indebted to the Illustrirte Zeitung) of the uniform designed for his use in tropical climates. It is made of light brown cloth of light weight; the coat is loose and comfortable and is decorated with the insignia of a general, aiguillettes, etc., while the trousers, which have red stripes down the sides, fit closely, and are worn inside of top boots of yellowish brown leather. The sword sheath is also of brown leather. The front of his helmet is ornamented with the Prussian eagle. The uniforms worn by the men of the Emperor's body guard are of English cocoa cloth, with collars and cuffs of blue cloth and gold embroidery, and those for the Empress' guard have red collars and cuffs and silver embroidery. All of the men of both guards have stars on their helmets. The servants of the suites also wear costumes of English cloth and have English caps. Under their coats they wear belts of light yellow leather, in which they carry revolvers and canteens.

The engraving referred to above was reproduced from a photograph taken by the court photographers and published in Illustrirte Zeitung.

THE UNIFORM OF THE FRENCH ARMY.

WHEN we examine the French soldier in his campaign uniform, we all agree in regarding him as picturesque. The shocking colors of the clothing, the prominent strands of the cord constituting the belt, the shapeless kepi and the turned-up trousers give him a physiognomy that is unique in Europe.

The observer with the least perspicacity quickly sees the inconvenience of such an accouterment, which seems to be the product of fancy solely. In fact, the headgear, deprived of a neck cover, exposes the man to sunstroke; and when it rains, the water runs down his back. The frock coat, which is intolerable in summer, is inadequate in winter. The footgear allows dust and humidity to enter, and, finally, the knapsack is so badly combined and arranged that it proves a terror to the soldier and gets the better of the most robust.

The soldier should be provided with practical clothing conformable to his anatomy, and which, while facilitating the play of his articulations, should aid in the easy adjustment of the shoulder belt. He should be protected from the sun and rain by a headgear at once light, strong, and of martial aspect. His knapsack should be so constructed that the weight may act directly upon the loins so as to ease the shoulders by so much; and, finally, the man should be protected from the rain by a short cape provided with a hood.

On a campaign there are two implacable enemies that must be triumphed over at any cost, and these are fatigue and inclement weather—adversaries which are much more to be dreaded than balls, and which lay four times as many victims upon the back. Battle, in fact, is the exception, while marching is continuous. Now, the general who, thanks to the practical sense of the equipment, leads the least fatigued troops upon the field will already have acquired an immense superiority over the exhausted elements of an adversary who has had less foresight.

If a war breaks out in the middle of the summer, our infantry will start in a kepi and frock coat and oppressed with the weight of a knapsack of barbarous construction; and this is so evident that marching in the sun is avoided in maneuvers. But in war the men will march notwithstanding all this, and will fall like so many flies.

It is time that this foolish practice were ended, and it is in the hope that it will be that we submit the following propositions to the Minister of War.

The Footgear.—This should consist of boots for the entire army, as it is really the most practical. Through its accordion plaits it compresses the leg without binding it. It permits of splashing about in the mud without any fear of getting the feet wet, and protects the latter against dust and aerates them perfectly, and thus prevents blisters.

The Trousers.—These should be wide and be plaited behind. A belt passing through a hem should be substituted for suspenders, and the extremities of the trousers should be tucked inside of the boots.

The Coat.—The constraint experienced by a soldier with a garment made of a single piece is easily explained. The belt, with its cartridge boxes, compresses the waist and prevents the upward movement of the arms. This inconvenience would disappear if the armholes were modified, but this is something that no one has ever thought of. The armhole should be wide, and the sleeve be still wider and be gathered at the upper part. The lower half should not be sewed to the edge of the armhole, but to a plait provided with a slit. The object of this slit is twofold: to aid, through its expansion, the vertical elevation of the arm and to give air to the armpit, which is always superheated. There should be a single row of buttons, so that the top of the coat may be opened in very hot weather.

The Overcoat.—The overcoat should, like the coat, be provided with wide armholes gathered at the top and with a plait and slit beneath, and be provided with a single row of five buttons. It should be furnished with cuffs that may be turned down over the hands in winter, and with side pockets and a turndown collar. An overcoat, when wet by persistent rain, will become saturated with at least two quarts of water, and the wearer, constantly damp, becomes sick. A cape with a hood, therefore, becomes necessary.

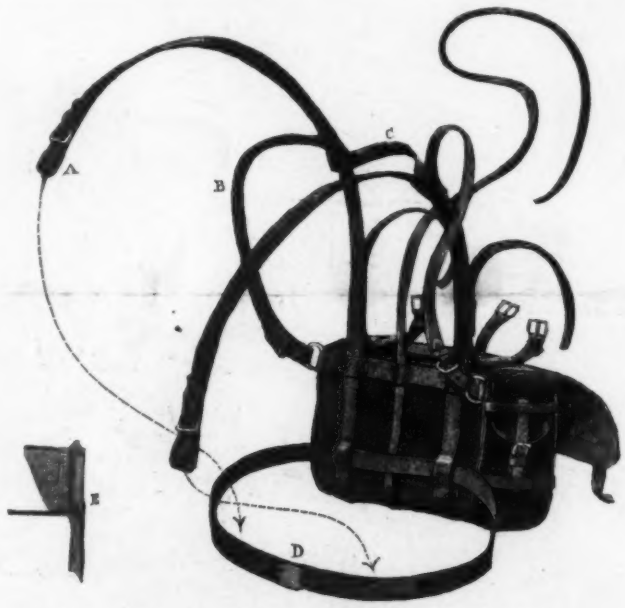
The Headgear.—The helmet should be of thin leather with a neck protector, and the strap should be protected with copper. The ventilation should be effected through an aperture under the neck protector communicating with the front of the crest, which should have an aperture on each side.

The Knapsack.—As the two points of resistance to a burden are the nape of the neck and the loins, the weight of the knapsack should be distributed over these two points. The knapsack, which should be of calfskin and without boards, should rest directly upon the loins, the form of which it should be made exactly to fit through a waist belt passing through two guides. At the top, back of the nape, a copper crosspiece connecting the shoulder belts should support the cartridge boxes already partly held by the waist belt. The shoulder belts should be fixed to the crosspiece and be attached to the knapsack on each side.

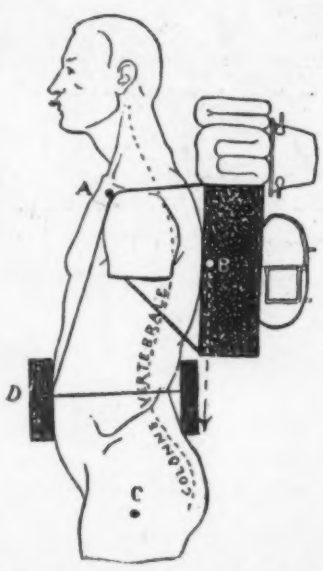
As the top of the thorax will no longer be compressed, the lungs will be able to play freely, the knapsack beginning only under the shoulder blades. As the waistbelt keeps the knapsack closely pressed to the loins, all shaking is prevented. For the above particulars and the engravings we are indebted to L'Illustration.

Inconvenience of the present coat. In raising the arms the belt rises from *C* to *C'*.

The plait, *E*, and its slit, *F*, to permit of raising the arms without any trouble.

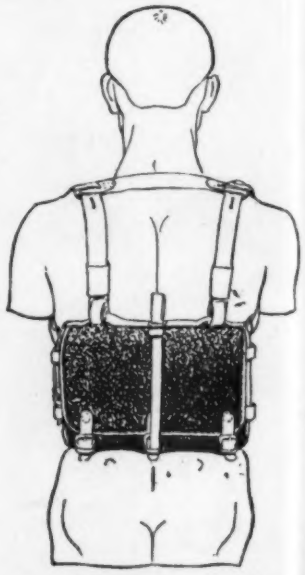


A, knapsack belts; *B*, cartridge-box belts; *C*, connecting strap; *D*, waist belt.



Present method of carrying the knapsack. The strong pressure from *A* to *B* prevents the play of the lungs.

With the new knapsack the weight acts upon *A B* and slightly upon *A G*. The crosspiece, *D*, aids the nape of the neck in carrying the knapsack.



New method of carrying the knapsack.

THE UNIFORM OF THE FRENCH ARMY.

THE SCOPE OF OCEANOGRAPHY.*

STATIC oceanography concerns itself with salt water considered independently of the movements manifested therein; it treats of the topography of the ocean beds and their constitution—that is, their lithology. It analyzes the waters, studies their influence upon the nature of bottoms, their multiple physical proper-

*J. Thoulet, in the Revue des Deux Mondes. Translated for the July Chautauquan. Condensed for Public Opinion.

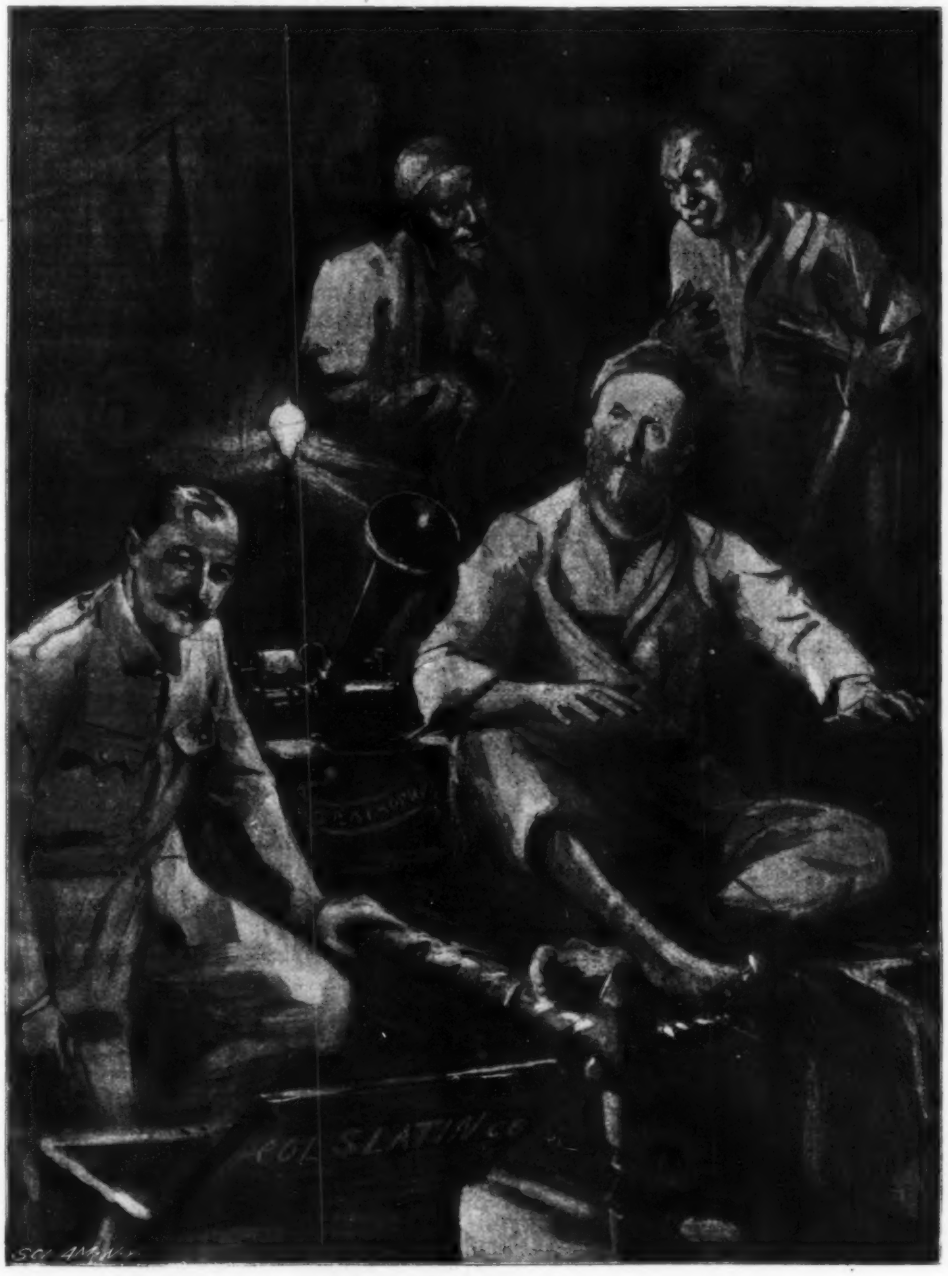
ties, the effects upon them of variations of temperature, their density and compressibility, the propagation of light through their strata, and the varied optic phenomena. Polar ice forms a chapter on the action of cold upon the sea.

Dynamic oceanography studies the ocean in movement, the waves which agitate its surface under the breath of the wind, the currents which thread its mass to a certain depth and result from the simultaneous action of heat, evaporation, the topography of the bottom, the geographical configuration of the surrounding continents, the climate, the rule of the winds —in a word, all those exterior causes which possess an influence, and inversely are all influenced; a cycle where everything commences and everything ends, and which as soon as it ceases to exist will mark the instant of the death of our planet, just as happens to the human body when the heart gives its last beat. Dynamic oceanography includes also the study of the tides, whose rhythmic movements accord with those of the heavenly bodies, and the examination of the processes by which the debris of the continents carried away by the winds or streams comes to a great common reservoir, breaks up in the midst of its waters, descends to the greatest depths, and accumulates there to form rocks analogous to most of those we now meet with upon our continents and which are the bottom of former oceans. Oceanography concerns itself also with the phenomena of contact between sea and land; it searches for the laws which preside at the formation of the deltas or bars which extend through the mouths of rivers, filling up the estuaries. It relates to the manner in which waves and currents cut the contour of the shores, to downs, coast ponds, and those madreporic constructions, coral atolls and islands, which are conquests of organic, the triumph of the infinite little, the zoophyte, over the infinite powerful, the ocean.

Oceanography touches, then, directly or indirectly, a crowd of sciences, and more than any other, geology. The present is at once the key of the past and the future, especially in natural history. For a long time geology dragged along in a sort of rut which oceanography forced it to leave. Rocks are of igneous, metamorphic, or sedimentary origin. The first two classes are the object of the researches of a special science, petrography. Stratigraphy deals with rocks of aqueous origin. Now, these having been formed under the waters, nothing can better throw light upon their genesis than observation of the manner in which they are now being created at the bottom of our oceans. This task concerns oceanography. When the particular character of the formations of the shores or the deep sea is known, when attentive observation and exact measurement of present phenomena have taught, for example, the necessary relation between the form and size of a grain of sand and the exact swiftness of the current which has carried it away, when the presence of a fixed proportion of clay in a sandy deposit permits us to conclude that this deposit was formed in calm or agitated water, when numerous and repeated measurements in different parts of the ocean have established the generality of these relations, that is, have discovered their laws, we shall be in condition to rebuild the past.

Oceanography possesses in maritime fisheries an application more important, if possible, than in geology, meteorology, and navigation; for this industry touches the very life of nations. No being escapes the influence of the medium which it inhabits and which rules its material existence as well as its habits, manners, and intellectual faculties. Nowhere are these close relations perceived in a more striking manner than in the waters, probably because they are found there in the state of least complication. The laws of oceanography are, then, the rational bases of methodical and consequently scientific fishing.

The industry of placing submarine telegraphs depends on oceanography in the same measure as the construction of railroads or canals depends on topography and geology. Perhaps the dependence is even greater for the telegraph lines.



THE GRAPHOPHONE IN THE HEART OF AFRICA.

THE GRAPHOPHONE AT OMDURMAN.

THE heart of the Soudan is the last place where we would expect to find a talking machine, but after the fall of Omdurman one of the most pathetic and interesting of the many scenes which were presented was one which occurred in Slatin Pasha's tent, in which a graphophone figured. The correspondent of The London Graphic strolled over to Col. Slatin's tent to obtain some information from the Pasha. To his astonishment, he heard the muffled sound of faint piano playing. Entering, he found that Col. Slatin had got out his graphophone and was exhibiting it to perhaps the strangest audience in the world. There sat Charles Neufeld, who had once been an accomplished pianist, with his eyes brimming over at the well remembered sounds which he had not heard during his ten long years of captivity. His fingers, unconsciously working, seemed to search in the air for the long lost keys. Behind the instrument, with blank dismay on their faces, stood the two native boys who had been Slatin Pasha's servants during his term of captivity at Omdurman, and who had connived at his escape. One of them was still lame from the fetters which had been riveted upon his ankles the day of his master's flight, and which had only been removed so that the man might carry a spear and buckler on the field of Omdurman. The engraving is from a drawing by Sydney P. Hall, from a sketch by Lionel James, and is republished from The Graphic.

LIGHTNING ON THE KITE WIRE.

EVER since the historical experiments of Franklin, in Philadelphia, and of DeRomas, in France, it has been a question to what extent it might be dangerous for the meteorologist to handle the wet cord or the modern iron or steel wire used in flying kites during thunderstorms. The early observers in Europe recommended a distinct safety connection or grounding of the wire a short distance in front of the observer. Rather severe shocks have been received in the ordinary course of kite flying, but so far as the record shows nothing really dangerous to human life. It was from the beginning evident that a dry cord could not convey a dangerous charge of electricity from the sky to the earth. We now know that the resistance of such a cord is so great that it would be burned or destroyed by small discharges long before a lightning flash occurs. It is only in proportion as the line becomes a more perfect conductor that it can have any appreciable influence in determining the location of the path of the discharge. When Prof. Richman was struck dead in his laboratory by a discharge of lightning, at St. Petersburg, he was using outside of the building a much larger conductor than would ever be associated with a kite. The strongest shocks hitherto observed, as received from kite lines, were those observed by DeRomas when he used a strong linen cord around which a small copper wire was wound, but these did him no harm.

These ancient experiments are brought to mind by the recent experience of some of the aerial observers for the Weather Bureau, whose reports have been kindly placed at the editor's disposal by Prof. Marvin.

Mr. E. E. Spencer, aerial observer, reports that at his station (Fort Thomas, near Cincinnati, O.), at 6 A. M., May 16, the kite line wire was completely destroyed by a heavy electric discharge from the air. The kite and meteorological register were landed safely about 20 miles distant and secured in good condition. About 12,000 feet of wire were out and 500 still remained on the reel, but all was burned or spoiled. Mr. Spencer says:

"The kite was started shortly after 4 A. M., seventy-fifth meridian time, and after the first few hundred feet of line had been paid out it struck a good current of air, and had taken out 5,000 feet of wire at 5 A. M. and 10,000 feet at 6 A. M. Observations were taken at both these hours. The kite was flying so steadily and at a very nice angle that I let out 12,160 feet, and was going to take an observation at 6:15 A. M. I had but just left the reel for this purpose when a very heavy electric current literally burned the wire up, particles of the melted wire adhering to the reel. A stream of fire seemed to run from the kite to the reel, completely burning the entire line. To me the most singular feature about it is the fact that at the time the wire was burned the kite was flying in a comparatively clear sky to the northeast, although a bank of clouds was visible in the west and a very light shower fell a few minutes afterward, continuing but a couple of minutes. No thunder was heard here. We watched the kite drift rapidly away to the northeast until it was lost to view away across the river, and then we went for it. The kite was tagged, with directions for notifying me if found. I notified all postmasters and school teachers within 20 miles and put similar notices in the newspapers. While I congratulate myself that I did not have hold of the reel when the wire parted, yet I may say that I had examined the switch less than two minutes before, and there was apparently very little electricity going through the wire, and we were congratulating ourselves that we were going to have a successful ascension after five days of hard work."

At Lansing, Mich., Mr. Charles A. Hyle, aerial observer, reports that:

"On May 18 the Weather Bureau kite was launched at 7:47 A. M.; by 8:01 7,500 feet of wire had been reeled out; at 8:20 A. M. distant thunder was heard in the west, and the wire began to be reeled in; rain began to fall at 8:52; at 9 A. M. a powerful bolt of lightning came down the wire, which was quickly consumed. From my position at the reel, where I had command of both brakes, I saw a shower of sparks, accompanied by a sharp report, and then a rope of smoke, stretching from the reel to the kite. In holding the wooden levers, I had released the iron guiding bar, which action I believe saved me from a heavy shock; the slight one that I did receive stunned me for an instant. Many citizens who were watching the kite report that a column of fire about a foot in diameter seemed to come down the wire; but those who were at a distance claim that the fire seemed to rise to the kite. All are agreed that the wire seemed to be on fire from one end to the other; immediately afterward a rope of smoke appeared throughout the length of the wire. As many as thirteen places were found where the discharge had jumped from the wire to the brake strap and penetrated the reel, one of them forming a weld between the brake strap and the reel. The kite was found about four miles north of the reel. Only two sticks were broken and will be repaired in a short time. The safety wire was fused, as also several of the guy wires. When the damaged wire that remained on the reel was removed, it was found that 4,420 feet were serviceable, and 4,015 feet had been destroyed by the discharge."

Under date of May 28, Mr. Paul DeGraw, aerial observer at Springfield, Ill., says:

"On the 27th, at 4 P. M., when 6,000 feet of kite line were out, a storm was seen approaching from the southwest. The work of reeling in the kite was begun immediately, and at 4:30 P. M., when the rain began, the dial reading was 503. A very few moments later the kite was apparently struck by lightning, which destroyed the wire between the kite and a point about

three feet from the reel, without harming the reel or the wire wound upon it. The kite was found about 1¼ miles north of the station, slightly damaged by the lightning. The amount of wire lost was 2,297 feet."

In a report from Mr. G. Harold Noyes, aerial observer at Topeka, Kan., dated May 31, he says:

"A kite ascension was made at 9:12 this morning and at 10:47 an altitude of 5,047 feet was observed. In pursuance of circular of May 20, from Chief of Instrument Division, in regard to electrical discharge in the thunderstorm season, I watched the amount and intensity of the electricity coming down the line, and at 11:50 I noticed it to be increasing. My assistant and I commenced to reel in the 8,000 feet of line that were then out, but it rained soon after we commenced reeling. We had just reeled in a little more than 3,000 feet, when, without warning, a bolt of electricity came down the wire, burning and breaking it, setting loose the kite. The concussion was so great that people standing 1,000 feet away thought we were shooting. We were reeling the kite in the usual manner, each with a hand on the iron steering handle of the reel box; the discharge stunned us measurably. . . . It was some moments before we could realize all that had happened. . . . The kite, which had an elevation of some 3,000 feet, had fallen nearly out of sight before we recovered our self-possession. The wire was hot when I picked it up and was burned brittle and black. The kite fell to the ground, breaking only one stick;, it is burned a little at one corner, which is evidently the point where the discharge entered. The self-registering apparatus is uninjured. The breaking of the wire was not caused by a continuous flow of electricity, but apparently by a single discharge. The rest of the wire on the reel is, I think, still good."

We do not know that any provision can be made for the prevention of the burning of the kite line when once a powerful discharge from the sky falls upon it. The line is too delicate to stand such discharges as must occur in the neighborhood of thunderstorms. It would destroy the efficiency of the kite to make the wire much larger, and, for the present, of course, it will be best not to expose the kite line to the chances of destruction.

Undoubtedly the discharges that destroy the wire are but preliminary ones, indicating the proximity of a still more disturbed condition, with severe lightning and thunder. If electrical apparatus and expert observers were sufficiently numerous, we should long since have been able to determine the breadth of the zone about any storm center within which it is useless to attempt to fly kites with fine steel wire. No such destructive discharges are recorded in ordinary fair weather, but there is always some electricity on the wire, and, of course, a connection between the reel and the ground is always at hand to carry off the small discharges that annoy the operator.

It will be observed that in the four preceding cases thunderstorms were reported from stations within 100 or 200 miles of the kite at the regular 8 A. M. telegraphic report. The kites were being flown in regions within which rain had fallen during the preceding twelve hours, where cloudy weather still prevailed, and where the surface winds were southerly, midway between regions of high and low pressure.

Afternoon thunderstorms are often called heat thunderstorms, because their occurrence is evidently dependent directly upon local temperatures. The thunderstorms that injured our kites on the mornings of May 16, 18, 27, and 31 all occurred as a part of widespread systems of thunderstorms attending general areas of low pressure. These have all been classed as "cyclonic" thunderstorms. These areas pass over the country at about the same rate as the areas of low pressure, but the thunderstorm region reaches out to a point about midway between the areas of low pressure and high pressure. By studying the weather map of the previous evening one may almost certainly foresee whether it will be safe to make the kite ascension early the next morning. It is evident that the successful use of the kite in the central portion of the Mississippi watershed, which is now covered by our sixteen kite stations, will depend upon the distribution of the tracks of the areas of low pressure.

The study of atmospheric electricity was prosecuted in former years until, under the advice of Prof. T. C. Mendenhall, it was decided that the electrometer and water-dropping collector were not likely to be of any practical value in weather forecasting. The study was, therefore, laid aside until some other reason should appear for the further prosecution of the subject. It is generally believed that the electrification of the air is not a matter of great importance in the study of the mechanics of the atmosphere. The electrification seems to be one of the minor results of the formation of fog, haze, cloud, and rain. Thus, Elster and Geitel, in their review of recent investigations into the subject of atmospheric electricity (see Weather Bureau Bulletin 11, Part 2, p. 514), say:

"Since regions of precipitation show the greatest variation of potential, the question arises whether such regions may be detected at a great distance by the behavior of the electrical apparatus; that is, whether it will not be possible to employ electrical measurements for forecasting the weather. This idea was tested in an extensive series of observations by Mendenhall. A negative result was obtained. One must, therefore, consider the electrical developments attending upon precipitation as being essentially local, and these may be excluded in the investigation of normal electricity. . . . One can either consider the whole earth as a sphere with a negative charge of electricity acting upon the atmosphere and the regions above it by induction, which is Exner's method of treatment, or he may, like Lord Kelvin, consider the atmosphere as the dielectric of a condenser of which the lower side, or the earth surface, is negative, and the upper side, or upper layer of the atmosphere, is positive."

The electric condition at the surface of the earth is subject to an annual and a diurnal variation, but still more to a non-periodic variation known as the electric storm. Exner shows the great need of measurement of potential fall at great heights above the earth's surface. Possibly the kite will offer an interesting method of attaining this desideratum.

Efforts in this direction have been made by Mr. A. G. McAdie. If the electricity originates in the earth, then it must be considered as being dissipated by discharge into the atmosphere, and the daily and annual variations of the normal terrestrial charge should be accompanied by an opposite daily and annual variation in the normal atmospheric charge. The electrical phenomena attending rain or other form of precipitation must be considered as disturbances of the normal electrical field.

The origin of the electrification observed on the kite wire, and the manner of transfer of electricity from the air to the wire, and vice versa, are but little understood. Prof. Marvin calls attention to the differences observed on different occasions, as follows: Sometimes everything goes to show that the wire is being continuously electrified, little by little, just as if every particle of air impinging upon the wire communicated to it or carried away a minute electrical charge. This seems to be the only circumstance of electrification in the winter time. In the summer season, however, in addition to the above phenomenon, he finds that sudden, often very considerable, impulsive rushes of electricity pass over the wire without the slightest apparent cause and in an infrequent and most irregular manner. All such discharges are strictly momentary, and, when one has been observed to pass, others are sure to follow, although several seconds, or even minutes, may intervene.

Prof. Marvin says his kite wire, in these cases, is the receiving instrument in an immense, wireless, telegraphic system. Nature is producing signals along his kite wire, which mean that flashes of lightning are passing at some far distant point; only rarely are these perceptible to the ordinary senses. All currents of the above-described character may be called inductive discharges. It seems probable in some cases that such currents may be strong enough to fuse the wire. This appears to have been the case at Cincinnati. Finally, the wire may be charged with electricity by being actually struck with lightning; that is, the wire forms part of the path chosen by the bolt in passing between the clouds and the earth. There thus appear to be at least three different conditions leading to the electrification of the kite line.

So long as the wire is grounded, the variations of potential at the earth and the upper end of the wire will always be sufficient to produce some slight currents; the wind blowing past the kite and wire tends to reduce the latter to the same electric potential as that of the air.

The editor has often experienced the tingling sensations and the violent nervous shock produced when a natural bolt of lightning has struck within a hundred feet of him, and he regards the discharges precipitated on these Weather Bureau kite wires as miniature premature bolts, probably too feeble to do any serious damage. The discharges that are brought down the kite line are to be considered as timely warnings. They may destroy the kite wire, but they tend to save the observer. They act like the patent fuses that melt before the boiler explodes, or the electric fuses that protect the dynamos, and are as precious to the observer in a thunderstorm as the safety wire in the bridle of the kite is important to it in a windstorm.

The kite wire used by the Weather Bureau is of the highest grade of steel, 0·028 inch in diameter, having a tensile strength of about 210 pounds, or at the rate of about 350,000 pounds to the square inch.

Prof. Marvin has employed the electric light current from the small dynamo of the Weather Bureau in testing the carrying power of the steel kite wire, and finds that a continuous current of about 15 amperes at about 100 volts is required to heat the wire to full red incandescence and maintain it at that temperature. Nearly a minute of time was consumed in reaching the maximum heat. This is doubtless the minimum strength of a destructive current, inasmuch as the wire must be torn asunder by the pull of the kite by the time it reaches a full red heat under a more or less steady current. Just how much greater current would be carried by the line when instantly fused by a momentary current in the full ventilation of the wind, is difficult to estimate, but it is undoubtedly much higher than the current employed in the test.

At a red heat the resistance of the wire is shown, by the rough tests made, to be about 0·7 ohm per foot, but this is nearly five times greater than the resistance when cold. From these data we are led to deduce that the electrical discharge which fused the 12,000 feet of line near Cincinnati had a potential of at least 130,000 volts.

Of course we are very sorrry to lose a continuous meteorological record within a thunder cloud, just because the lightning persists in burning up our kite line; but the record must be obtained; the progress of meteorology must not be thwarted; a simple method for overcoming the difficulty must be found.—Monthly Weather Review.

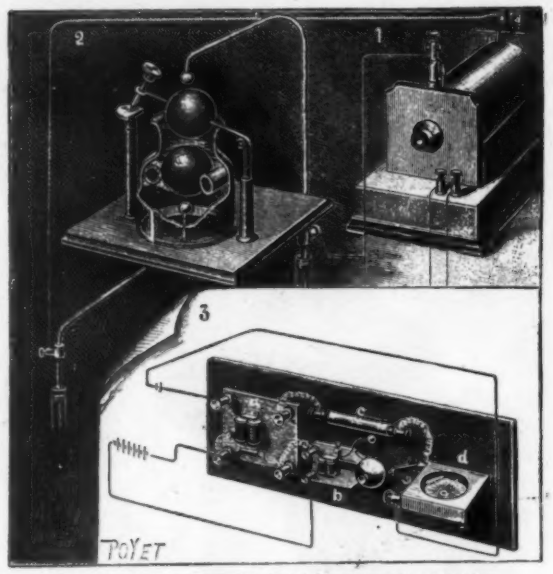


FIG. 1.—APPARATUS FOR TELEGRAPHING WITHOUT WIRES.

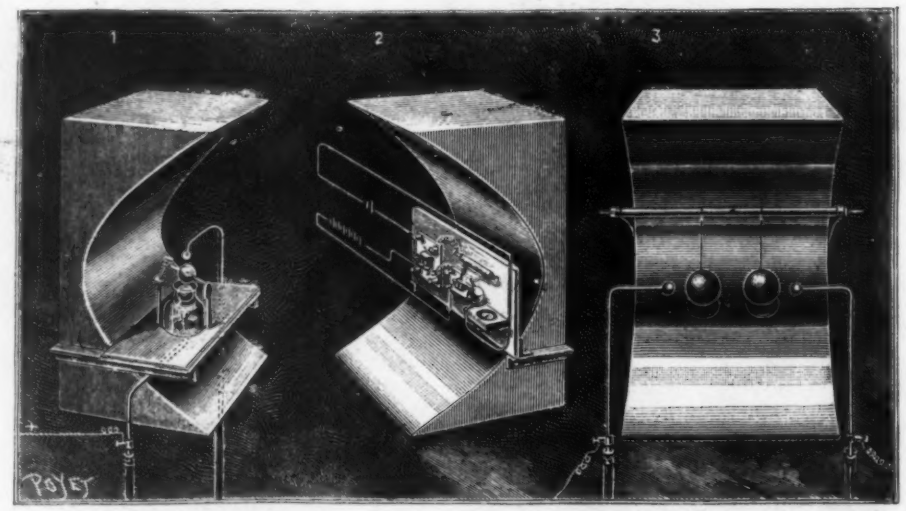


FIG. 2.—ARRANGEMENT OF THE APPARATUS AT THE FOCUS OF A REFLECTOR.

TELEGRAPHY WITHOUT WIRES.

WE illustrate herewith an apparatus, devised by M. Paul Dosne and described in La Nature, for performing experiments in wireless telegraphy.

The bobbin employed is a Ruhmkorff coil (Fig. 1, No. 1) giving a 4 inch spark. The oscillator (No. 2) is formed of two metallic spheres, one of which, at the lower part, is held beneath the mouth of a jar by means of a ring formed of a rubber tube. The whole is fastened above and below by means of sealing wax. The other sphere is suspended from a rod movable around a joint at one side and provided at the opposite extremity with a leveling screw that permits of regulating the distance apart of the two spheres. The part of the jar containing the two spheres is filled with oil of vaseline. Above and below the spheres there are two smaller ones, ¾ inch in diameter, held by copper rods fixed in tubes of thick glass. These rods are connected with the secondary wires of the Ruhmkorff coil.

The receiver (No. 3) is made up as follows: A circuit

is formed of a Leclanche battery, of a relay, *a*, of a Branly tube, *c*, and of a galvanoscope, *d*, which may be cut out of the circuit at will. The freeing of the relay closes the circuit of a group of six batteries that actuates a bell, *b*. The place of the latter is so selected that, after the hammer has struck the bell, it shall strike the Branly tube, *c*. This latter is formed of a glass tube $\frac{1}{4}$ inch in diameter and $\frac{3}{4}$ inch in length. It is provided at its extremities with corks into which pass two rods terminating in the interior in a small, well soldered disk. Between the two disks are spread filings of pure nickel mixed with $\frac{1}{10}$ of silver. The pressure of the two pistons upon the filings is regulated by hand.

This apparatus has permitted M. Dosne to perform a few experiments at 75 or 80 feet. In order to increase the effect still further, he has arranged his apparatus at the foci of two parabolic reflectors (Fig. 2, Nos. 1 and 2) consisting of a plate of zinc tacked to the surface of a curvature formed in a block of wood. If it be desired to perform the experiments at a short distance, it is possible likewise to employ as an oscillator two balls suspended by silk threads (No. 3) from a rod inclosed in a glass tube. As may be seen, these experiments are easily performed.

SMITH'S TRAMWAY CHRONOGRAPH.

WE illustrate herewith a form of the tram chronograph invented by Mr. F. J. Jervis Smith, F.R.S., and constructed by Messrs. Elliott Brothers, of London, specially for measuring the velocities of projectiles. Mr. Jervis Smith's original instrument was devised mainly with a view to the measurement of physiological reactions and such physical measurements as the velocity of sound in different materials. Fig. 1, which has been prepared from a photograph of the instrument, shows its general arrangement very clearly. A carriage, *b* (Figs. 1, 2, and 3), is arranged to run along the rail, *a*. The desired velocity is imparted to it by the springs, *c*, shown on the right, the carriage being pushed up against a piston which stretches these springs, and held fast by a catch released by a trigger line shown toward the top of Fig. 2. At the end of its travel the carriage is brought to rest by a brake consisting of a leather strap, *d*, kept taut by a spring, as shown. A stop on the carriage passing underneath this strap, the rapidly increasing friction brings the carriage quietly to rest. To reduce the running friction, the carriage is mounted on wheels, and at the same time the rail is very slightly tilted, so as to just compensate the small frictional resistance still remaining. The rail, it will be seen, is supported by three leveling screws, and in use it is essential that these screws shall be adjusted so as to bring the face of the rail into a plane truly vertical. The feet of these three screws rest respectively in a hole, a slot, and a plane, after the method now common with many different forms of measuring instruments.

The carriage serves to support a piece of glass having its lower edge ground truly straight. This glass is slightly smoked, and an accurately standardized tuning fork is so arranged that a style secured to one of its prongs scratches an undulating line through this coating of smoke as the carriage is shot past it, on releasing the trigger as already explained. This sinuous line serves as the time measurement, and to facilitate the counting of the number of vibrations traced, it is usual to draw a center line through the waves by bringing the carriage back while the fork is not vibrating. This tuning fork, it will be seen, is carried on a separate standard also fitted with leveling screws, as shown in Figs. 2 and 4. This standard also serves to support the styles which trace on the plate the times of passage of the shot through the different screens. A vertical traversing screw enables a set of these styles to be raised or lowered, so as to obtain more than one record on a given plate. They can also be adjusted separately in a horizontal direction till the point of each just touches the plate. A tangent screw, *e*, shown in Fig. 3, then serves as a stop to adjust the pressure of the whole on the plate to the necessary degree.

Each of these styles is carried on a light aluminum arm attached to the armature of an electromagnet. The latter are made with small subdivided cores and large yokes, a necessary condition if the time lag is to be small and uniform. A light spring tends to pull the armatures away from the magnet poles, but is unable to overcome the attraction of the latter till the current is interrupted by the passage of a shot through the corresponding screen. In order to secure with certainty the coincidence of the passage of a shot through the screens with that of the chronograph carriage past the recording styles, the carriage is itself, as it starts on its run, caused to fire the gun by completing the circuit of the electric primer. The necessary contacts for this are arranged at the back of the instruments. After the records have been obtained in the way explained, the times are measured by projecting with a T-square the breaks on the lines traced by the recording styles on to the time record as traced by the tuning fork. The number of undulations intercepted by the successive points of projection is then a measure of the time desired. In certain cases where permanent records are desired, a piece of glass paper, mounted temporarily on a copper plate, is substituted for the glass and is coated with smoke in the same way. After the records have been traced the smoked coating is fixed by passing the paper through a bath of dilute photographic varnish.

We are indebted to The London Engineering for the article and engravings.

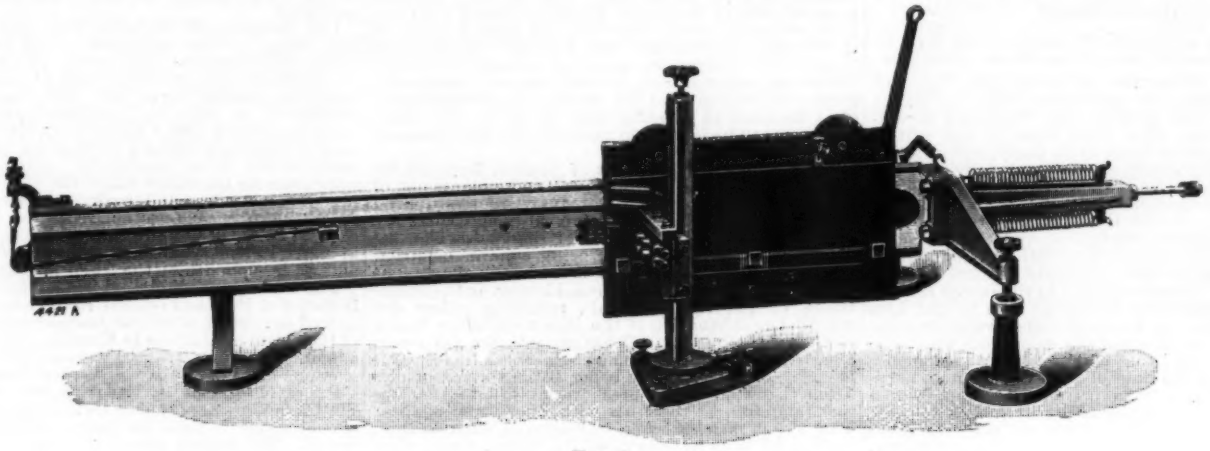
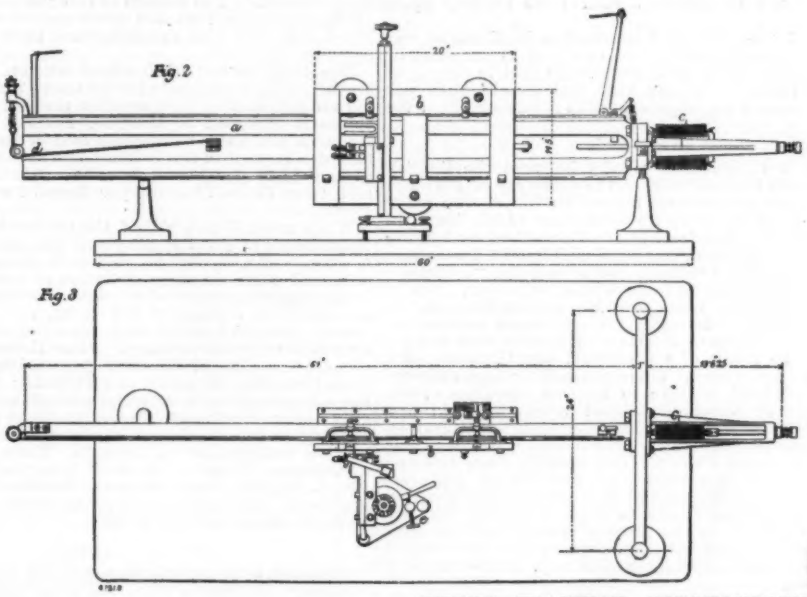
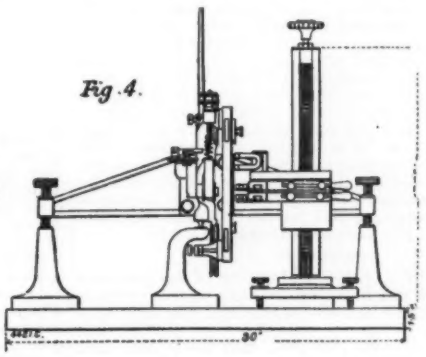


FIG. 1.





SMITH'S TRAMWAY CHRONOGRAPH.

RUBBER VARNISH.

By RALPH W. GRAY.

THE varnish business, like the manufacture of rubber goods, is what is known as a secret business. There are in the United States about a hundred factories devoted to the manufacture of varnishes for furniture, carriage and housework, with a few that devote their energies to manufacturing fine goods for artists. The use of varnish primarily is to give luster and durability to whatever it covers. In India rubber work the varnish is put on not alone to add durability, but to prevent the efflorescence of the sulphur. The bases of most varnishes are linseed oil and spirits of turpentine, but to those that are to be used on hard surfaces where a special luster is required, certain gums are added to give brilliancy and hardness. These gums are all of the resin families, the best being the hard fossil gums known as Kauri and Zanzibar gums. Certain varnishes are made from amber and a fine varnish is also made from celluloid. The more elastic a varnish is to be, the smaller the percentage of gum that is put into it. It follows, therefore, that in making rubber varnishes little or no gum is used.

As the bulk of rubber varnish is made of linseed oil, the secret of the business would naturally lie in its preparation. Many of the rubber factories have in connection with their plant a small brick building where is set a large caldron in which the oil is boiled. The operation is more or less attended with danger from fire, and it is therefore conducted at some distance from the main building Considerable skill is acquired by the men who have charge of manufacturing the varnish, and as a rule those who are expert in this line do nothing else, and they receive good wages. This is just, as they incur considerable peril, many accidents having occurred in which the laborers have been badly injured.

The oil, after having been boiled to the proper consistency, either with or without the addition of a certain percentage of sulphur, Prussian blue, or resin, is taken in the light, clear, pasty mass to the varnishing rooms, where it is thinned with spirits of turpentine and applied to the goods by means of brushes. There are no special tests for the quality of varnish, the ordinary way of examining it being to spread a thin film upon a piece of glass and to look through it toward the light, with a view of examining its clearness. Often the piece of glass is put in the sunlight, where the film will dry, and allowed to stand for a year. A first class varnish during this period should not shrink largely, nor should it crack. Linseed oil, however, is capable of absorbing a great quantity of oxygen, and unless carefully and skillfully boiled, will continue the process and crack.

Chemically, very little is known concerning the drying of linseed oil, but it is likely that the subject will be investigated thoroughly before long, with the means that are now within reach of the modern chemist. As linseed oil itself is a powerful oxidizer, those who purchase it for use in varnish are very particular in getting exactly the kind they need, and will not take chances on any brands, even if the price be considerably to their advantage. A piece of canvas spread with a linseed oil varnish that has not finished its oxidization will in the course of time be thoroughly destroyed, and the same effect will be produced upon a thin rubber surface. Hence it is quite important that this fluid be carefully tested before use. Some manufacturers make a varnish for rubber boots and shoes of the oil alone boiled to the proper consistency, while others add various driers and certain gums. It is a question if it would not be wise for these same manufacturers to examine carefully the various gums used in the regular varnishes to see if a certain percentage of them added to the linseed oil would not give an added brilliancy and a better durability. Of course this amount would naturally be very small, as Kauri, for instance, if added in too great proportions, would have a tendency to crack when the goods are stretched.

In an experiment recently tried in a large rubber factory, ten per cent. of Kauri gum was added to the varnish and found to be altogether too much. Three per cent., however, gave a very pleasing result and seemed to have a luster that was not shown in the

regular oil varnish. Varnish for rubber work, as a rule, is applied before the goods are heated; therefore, it has the chance of additional drying during that operation. Many of the goods when they come out of the heater are quite sticky, but a very little airing remedies this. To-day on almost all rubber goods that are put on the market there is found to be a very fair quality of oil varnish. A good grade of rubber when covered with varnish gives a far better result than a poorer grade, as the solvent often strikes through the shoddy or poor grade rubber and appears on the cloth itself, giving a stained effect, and, furthermore, materially weakening the body of the rubber. In experimenting with varnishes a variety of solvents have been tried for the purpose of cutting the boiled oil. Of these any of the hydrocarbons will answer, because they are indifferent to atmospheric action and possess great solvent power. Oil of turpentine, however, is the best, and benzine the cheapest, of the various solvents in use.—India Rubber World.

THE PORTLAND CEMENT INDUSTRY OF THE WORLD.*

By Bernard L. Green, Member of the Civil Engineers' Club of Cleveland.

The technical literature on the subject of cement has grown to such enormous proportions in recent years that the writer feels no little hesitation in venturing an addition. But, while some of the matter here presented may be familiar to many, much of it is the result of personal investigation and study, and it is hoped that the paper as a whole may contain a morsel or two of valuable matter for all.

It is interesting to note that probably the first man to determine the great principle of hydraulic cements was Smeaton, and in connection with the foundation of the very lighthouse that has made his name famous the world over. His experiments in the search for materials for a satisfactory hydraulic lime taught him that the acquisition of hardness under water does not depend upon the hardness of the stone from which the lime is made (a theory that had previously been generally believed from the time of Vitruvius), but in burning and falling down to a powder of a buff-colored tinge, and in containing a considerable quantity of clay. These experiments, though made in 1756, were not published until 1791 in his "Narrative of the Building, etc., of the Eddystone Lighthouse." In this same year Dr. Barker's accidental discovery of the hydraulic properties of the septaria on the island of Sheppey started an immense business in the manufacture of natural cements. So great did the demand for them become that grave fears were entertained of the early exhaustion of supply, and consequently the search was eager for a process of making cement artificially. Prominent in the study of the problem were Pasley, in England, and Vicat, in France, and the latter in 1818 published a method for making hydraulic lime from clay and lime. In 1822 Frost took out a patent in England for the making of hydraulic lime by the method of Vicat, and the plant he established at Swanscombe, on the Thames, has developed into that of Messrs. White Brothers.

Among the many searching for an artificial method of cement manufacture was Joseph Aspdin, a bricklayer of Leeds, who, in 1824, having discovered a manner of combining certain ingredients to form a cement fairly hydraulic, adopted the custom of others who sold various kinds of cements to give them distinctive names or brands. He chose to call his product "Portland Cement" in consequence of its fancied resemblance in point of color and texture to the oölitic limestone of the island of Portland, well known and in great favor in England as a building stone.

Portland cement is produced from the intimate mixture of lime and clay, burned to a point just short of vitrifaction and ground to a fine powder. It is thus essentially an artificial product and clearly distinguishable from the natural cements. It can be made from any materials having the various necessary ingredients in the proper proportions, and these proportions may vary between narrow limits, depending somewhat on the method of manufacture. Scientists have now proved almost conclusively just what chemical combinations and reactions take place upon the calcining of the raw materials, and also when the resulting cement is mixed with water and allowed to set. So there is nothing in the fundamental principles of Portland cement making in which one manufacturer can claim superiority over his rivals—no secret processes, no patented methods; and his only chances to win the race of keen competition lie in natural advantages of raw material, location of plant, cost of fuel, choice of mechanical appliances and price of labor. These are the main points of comparison between different countries and different factories, and naturally form the chief objects of interest in such a comparative study.

ENGLAND.

Proceeding now to the consideration of the past and present state of the industry in each of the cement-producing countries in its turn, England will naturally have first place.

The period between 1824 and 1850 forms the dark ages of the industry, and little is known of its history during that time. At the latter date there were but four factories making Portland cement, and the process was still crude and the product of uneven and unreliable quality. Competition and tests made by interested parties soon increased the general confidence in the material, other factories sprang into existence, and the product increased rapidly and steadily. In 1874 we find an estimate of the exports from England for that year placed at 1,350,000 barrels, and exports increased steadily to 3,500,000 barrels in 1890.

The Portland cement factories of England may be divided into two general classes, based on the materials used. The first is closely confined to the lower Thames and the Medway, an adjoining estuary, and the materials used are chalk, found in abundance in the rolling country bordering these streams, and an unctuous blue clay, commonly called Gault clay, largely obtained from the beds of the streams by dredging. Fully 80 per cent. of all the English Portlands are produced from this district, and practically all the exports to America are from them.

The old original process, or "back" process, is still largely in use in the Thames district, although many manufacturers are changing to cheaper and more rapid methods. The former method seems to produce the best cement still, and is much favored by many engineers in England; but the greater time consumed and the higher cost of handling are rapidly making its use prohibitory in competition. It consists of mixing and grinding the chalk and clay together in sludge mills with 120 to 140 per cent. of water and floating off the finely divided particles over weirs to settling backs. When a back is filled, the mixture is allowed to settle and the clear water is drawn off over weirs as far as possible, the sun then drying the mass to the consistency of warm butter. (This method of drying often takes a month.) It is then spread on drying floors, where, either by separate coke fires or by waste heat from the kilns, it is evaporated to dryness.

The new method, coming more and more into use and known as the semi-wet or Goreham process, consists of mixing with only 30 to 40 per cent. of water in similar sludge mills, followed by grinding to a creamy texture between millstones. The mixture is then pumped directly to drying floors connected with the kilns, where the waste heat dries the mass in about 18 to 20 hours. It is evident that the latter process must be much the cheaper, saving about a month of time between raw materials and finished cement, besides the great area required for the backs; but the most complete mechanical grinding together of the raw materials seems to be inferior in results to the old process of mixing by water.

The second general division of English factories before mentioned, and comprising all those plants not of the Medway-Thames district, may be represented by the works upon the river Tyne, although there are several factories in other parts of England. The materials are totally different, being a hard, compact, shaly limestone, called blue lias, rich in clay. The methods consequently differ considerably in the preparation of the raw materials, requiring either dry grinding or calcination of the lime rock before finally mixing with the clay. These cements are not generally so highly favored among engineers as those of the Medway-Thames district, being liable to lack of uniformity, owing to the great variability in the lime rock, and frequent trouble with blowing or swelling. The writer was shown a briquette of such cement, having an original length of 7½ inches, which, after the boiling test, had swelled to 8 inches. This, of course, was an extreme case.

All English cements are carefully inspected before use, to see that they are "cool," and if there is the slightest tendency to failure under tests for constancy of volume, they are spread out on warehouse floors to aerate or be "purged" before they may be used. This is a point which should be emphasized. The danger in using recently ground cement is not generally recognized in this country, and many consumers still specify that their Portland cement shall be "freshly ground." The danger is two-fold, since a highly limed cement is much more likely to blow when fresh than after it has somewhat seasoned, and no cement, whether highly limed or not, should be used until the heat produced in grinding has had time to subside. While the English cements seem to require somewhat more attention in this direction than those of other countries, still if this point were more carefully watched in the United States better results would be obtained, and many American cements, which some engineers now believe somewhat treacherous on this score, would be accepted with more alacrity upon works.

In 1895 the estimated production in England was 8,300,000 barrels per annum, or about 26 per cent. of the total European production. Its cost in the open market during the past year was about $1.40 per barrel, though on large contracts it was obtained for $1.25.

FRANCE.

There is considerable rivalry between the English and French for the credit of the discovery of Portland cement, and not without reason, for Vicat, who made the subject a life study up to the time of his death, in 1861, published the description of a method for making an artificial hydraulic material which must have been quite as good as Aspdin's; but he called it "hydraulic lime," and thus seems to have been ruled out. But it was not for many years that the manufacture of this material was undertaken on any large commercial scale. The works of the Gate of France were started in 1842, the result of a discovery, near Grenoble, of a natural cement rock. These works later began the use of an artificial mixture to increase the time of set. The sons of Vicat established works in 1857; and about 1859 Demarle, who had been making natural cement near Boulogne for some fourteen years, was successful in copying the English cements; was the first of several manufacturers to impress French engineers with the excellent qualities of their domestic product. About 1870, French cements began to steadily displace English brands in the French market until in 1885, when the manufacture came under the direction of the government, foreign brands were almost entirely displaced.

The government control over the industry mentioned above is worthy of note. It is a law that government inspectors shall have access to works at any time and have power to order corrections in the mixtures, or changes in the details of manufacture, if they see fit. The manufacturers thus have less chance for competition and the exercise of individual methods, and the system might be expected to militate against healthy progress in the quality of product. Such does not seem to be the case, however, if one may judge from published reports of results of tests upon several of the most largely used brands.

The materials mostly in use are marl and clay, or chalk and clay. The methods of manufacture are much the same as those in England, but more care is taken as to regularity of mixture, burning and grinding.

Although the total output in 1880 was only about 750,000 barrels, it is at present nearly 3,000,000 barrels.

GERMANY.

The first step toward the manufacture of Portland cement in Germany was taken in 1853, when Dr. Hermann Bleibtreu, of Bonn, erected an experimental station at Züllchow, near Stettin, on the Oder. The experiments led, in 1855, to the establishment of a Portland cement plant in that place, the product of which so rapidly found favor that an annual production of 30,000 barrels was easily disposed of. Other factories soon began operations in various parts of the country: the Mannheimer, in 1861, and those of Lüneburg, Amöneburg, etc., in rapid succession. The methods were at first directly copied from the English, whose product had previously held the highest reputation in Germany; but it was soon found that the various classes of materials used in different localities would not at all adapt themselves to these methods. German patience and careful study prevailed, however; new and more appropriate methods were devised by the experts employed by the various makers; and the result has been most gratifying. Not only has the quality become equal to that of English cements, but it has often considerably surpassed it. By 1877, at which date there were some thirty factories, with an aggregate annual output of 2,500,000 barrels, the peculiarities of the various materials in use in different localities were pretty well understood and the methods perfected.

The Germans are probably the most advanced of any nation in the realization of the great variety of uses to which cement lends itself. While the English use it for strictly structural work in concrete foundations, breakwater works, etc., and the French have adopted it at times for more ornamental work, Germany constantly uses it in the most diverse ways. One finds it forming a wearing surface for pavements, the cornices and other ornamental work of buildings—sometimes for the entire walls—for curbing, sidewalks, heavy balustrades, and even for statuary. Perhaps some will, in this connection, recall the beauty of the colossal statue of Columbus at the Chicago Exposition, in 1893. It stood at the entrance to Machinery Hall, and was a monolith of the Alsen Portland cement.

There are at the present time some sixty different factories of Portland cement in Germany, with a total annual output of 13,500,000 barrels—over 40 per cent. of the entire production in Europe. The exports now amount to about 3,000,000 barrels each year, of which over one-third comes to the United States.

Prices of cement in Germany are very low. The Stettin factories are said to be manufacturing at a net cost of about 77 cents per barrel, not including cost of barrel. The average price in the open market appears to be about $1.25 per barrel. A pool of the manufacturers of Germany considerably limits the brands of cement that may be offered for use in any one locality. The question to German engineers as to which brand of cement they consider the best is always answered, "We are allowed no preference; such a brand (naming, perhaps, the factory nearest to hand) is the only one we ever use." Indeed, competition is so fierce that some such protection seems almost necessary; and since the careful government supervision and the organization of the manufacturers themselves keep the quality to a high standard, and the price within bounds, this pooling for sales seems harmless.

BELGIUM.

The Portland cement industry is said to have been carried into Belgium from England by a son-in-law of Aspdin, although a recent consular report states that it was first carried on in 1872 by Messrs. Duffossez & Henry, of Cronfestu. Its history in that country is, however, obscure and probably of little interest. Belgium is pre-eminently the home of the "Natural Portland Cement." The makers of this material and of the artificial or true Portland have each their organizations, but the two organizations have nothing in common.

The total output of Portland cement, both natural and artificial, is estimated to be about 2,250,000 barrels per annum, and of this amount probably about two-thirds is exported to Holland, France, Switzerland, America, and even to England and Germany to some extent. Its cost in the Belgian market varies between $1 and $1.25 per barrel for the artificial Portlands and from 65 to 70 cents per barrel for the natural Portlands.

While most, if not all, of the artificial Portlands of Belgium are of good quality and will rank with those of other countries, Belgian cement in general holds but a second place in the estimation of engineers. The large quantities exported to other countries find a market chiefly on account of low price, and they are frequently excluded when work requiring a high class of cement is to be undertaken. Thus Holland, with no cement factories of its own, imports large quantities from Germany, England, and Belgium; but the engineers generally rank the latter cements as good for use only under conditions similar to those in our own country under which our engineers use the cheaper but less uniform natural cements. There is in Holland a difference in price of about 25 cents per barrel between Belgian and German Portlands, the best quality of the former costing about $1.23 per barrel, while the latter sells for $1.50.

AUSTRIA-HUNGARY.

Statistics from Austria-Hungary are somewhat confounded. In Austria there are some eleven factories forming an association similar to that of Germany, and the quality of their products is good. The aggregate annual output from these is about 1,000,000 barrels. Information concerning other factories, not represented in the association, has not been obtained. Austria ships a considerable amount of cement to Hungary and to other countries and provinces in Eastern Europe. The Association of Manufacturers was organized about the same time as that of Germany, and the researches and steps taken for the improvement of the product have been along much the same lines.

Hungary has about a dozen factories, but their annual output is not published. Small quantities are imported from Germany, as well as some 100,000 barrels annually from Austria. Domestic cement costs about $1.30 per barrel and imported about $2.

RUSSIA.

Portland cement was made as early as 1857 in Russia, but did not receive careful attention nor attain reputation till about 1888, and up to that time large quantities were imported from Germany. By 1890, however, there were eight factories in existence, pro-

* Abstract from the Journal of the Association of Engineering Societies.

ducing 900,000 barrels per year, and the German imports dwindled to very low figures. At the present time there are fourteen factories and the annual output is estimated at over 2,000,000 barrels, practically all consumed within the country.

SCANDINAVIA.

The Scandinavian states have a few very good Portland factories. In Denmark the largest and best equipped plant is at Aalburg, on an arm of the sea running up into the province of Jutland. The materials used are chalk and clay. Modern methods prevail throughout, a combination of the wet and dry processes is used, the burning is in continuous shaft kilns, and the grinding is done by ball mills, followed by the use of tube mills for pulverization. There are in all five or six manufactories in Denmark, with an aggregate annual output of about 400,000 barrels, of which the Aalburg works turns out about 250,000.

In Sweden probably the largest and best known works are those of the Skanska Company, at Malmo. This plant was established in 1872, and its present annual output from two plants is about 225,000 barrels. Four other companies, including a solitary one recently built in Norway, have an aggregate output of 275,000 barrels, making a total, for Sweden and Norway, of 500,000 barrels. About 100,000 barrels of this are exported to Denmark, Russia, and America. English and Belgian brands are imported in small quantities, but the home product is almost exclusively used. The price of cements in the Swedish market runs from $2.15 to $2.30 per barrel—rather a high rate compared with those in other European countries.

SWITZERLAND.

Switzerland has a few factories, the one at Aarau enjoying a certain reputation, but the quantities manufactured are insignificant. Considerable quantities are imported from Germany and Belgium.

ITALY.

In Italy there are three or four firms operating plants with a total annual product of about 800,000 barrels. The principal works are at Casale in the province of Monferrato. A new factory has recently been started at Civitavecchia, near Rome. These cements may nearly all be classed as natural Portlands, the process of manufacture being much like that in Belgium, already described. Italy imports about 700,000 barrels of cement annually, or about one-half of the quantity consumed, since there is very little exported. Most of the imported cement comes from France. The price varies from $1.75 to $2 per barrel, according to quality, there being two qualities, much as noted in France. Contrary to the general belief, Italy is now using more cement than pozzuolana. The latter material, so noted as an Italian cement for years, has yielded first place to Portland cement on important works in that country except in the Roman and Neapolitan districts.

SPAIN.

Spain has no Portland cement factories, natural cement alone being made, but considerable quantities of this are manufactured. Portland cement is imported largely from France, though English brands are used to a considerable extent. The imported Portlands cost from $1.65 to $1.80 per barrel.

OTHER FOREIGN COUNTRIES.

Portland cement works in other parts of the world are not of great importance. Their output is small, and generally the plants have been erected simply to meet the demand in some locality on some piece of work where there are proper materials in convenient position. There are works in India, notably at Ghooting, where lime and calcite are used, and at Madras, where shell lime and clay form the ingredients. In New Zealand there is a well organized plant at Mahmangi, north of Auckland. Portland cement is also made at Tongshan, in China, from limestone, fire clay, marl and a rough china clay. The wet process is used exclusively, and the plant has modern equipment. Its capacity is said to be about 100,000 barrels per annum. The product is used wholly in government works.

The industry is developing steadily in Canada, and as the demand is rapidly increasing and good materials are said to be plentiful, it may be expected that still greater growth will ensue. The output in two years has been increased over 150 per cent. The Canadian Pacific Railway's works at Vancouver, B. C., built about 1890, are worthy of note. A limestone rock is used, being ground dry and then mixed with just sufficient water to be handled in brick machines. The Hoffman kiln is used and slack is the fuel instead of coke. It is claimed that by restricting the amount of water, 300 pounds of slack are made to sufflce for burning a ton of cement, against 700 pounds of coke by the wet process.

Works are to be found in South America, at Parahaybo del Norte and in many other places, but they are of little consequence in relation to the great industry as it exists among the great European and American nations.

UNITED STATES.

In our own country Portland cement was imported from England for several years before its manufacture at home was begun. The United States government was probably the first to use it in large quantities, upon harbor and coast defense works about the time of the Civil War. The amounts imported for other purposes were small and the price was from $7 to $9 per barrel. Attention was rapidly drawn to the value of the material, and imports steadily increased. By 1875 the price had decreased to $3.50 and $4 per barrel, and in 1877 58,450 barrels were imported into New York.

In 1875 Mr. D. O. Saylor, after three years of experiment and study, placed upon the market a very good American Portland, and his success started many others in the industry. Some were doomed to failure, but the number of successful manufacturers steadily increased, and in 1890 there were 16 factories, making 335,500 barrels, or 14 per cent. of the total amount consumed. At present there are 30 factories, producing 2,304,000 barrels, and new plants are rapidly springing into existence. A more detailed history of the establishment of various factories may be found in a paper by Mr. Robert W. Lesley, published in the Journal of the Association of Engineering Societies for November, 1895.

About 88 per cent. of the Portlands made in this country come from New York, New Jersey, Pennsylvania and Ohio, the other 12 per cent. being distributed between Texas, Colorado, Dakota, California, Oregon, Utah and Michigan. The materials available have not the natural advantages of those in England, but resemble more nearly the materials in Southern and Central Germany. The various plants all use one of two classes of materials: first, a more or less argillaceous limestone rock, which is treated with clay to form the proper proportions; and, second, a marl artificially mixed with clay. The only exception, to the writer's knowledge, is the works of the Western Cement Company, at Yankton, S. D., where chalk is found, and where methods of the Medway-Thames district of England are available. Under the first head may be classed the mills of Western Pennsylvania and Southern Ohio, while the plants of New York and Northern Ohio are representative of the second class. Statistics show that last year one-third of all the factories, producing 23 per cent. of the total output of the country, used marl, the remainder using limestone.

Cost of labor is another disadvantage against which American manufacturers must contend. The cost of cement manufacture is about 87 per cent. labor, divided as follows:

Quarrying	40 per cent.
Burning	6 " "
Grinding	6 " "
Moving, etc.	5 " "
Packing	3 " "
Coal and coke, staves and heading	27 " "
Total	87 per cent.

It is only by the use of machinery best adapted to the purpose and by profiting by all the advantages of location, thus saving time and employing as little labor as possible, that the American has brought his product to its present perfection and his price to the point of sharp and successful competition with the foreign cements that have enjoyed so great demand in the past.

The semi-wet method is most commonly used in preparing the materials for the kiln, various devices for wet grinding being in use in different mills. The dry grinding is also frequently employed. There are one or two plants making a natural Portland, somewhat after the Belgian methods, but so far as the writer is aware, in every case the materials run more uniformly and the results are much better.

Both the continuous and intermittent forms of kilns are in use, and various forms of each are met with. The rotary kiln is largely used. Though this machine was first devised in England, it has been so successfully developed in this country that it may almost be called an American invention. It never succeeded very well in Europe, and its use here is viewed with a little surprise by European manufacturers. It is true the process is not adapted to all classes of materials, and cylinders have met with failure in some mills. But where the raw materials will permit its use, it does very good work and proves a very economical machine. At present about 48 per cent. of the total output of the United States is burned in rotary kilns. Petroleum fuel is used in them, while gas coke is the ordinary fuel in other forms of kilns.

Perhaps the best method of showing concisely the comparative progress of the Portland cement industry in the principal countries may be derived from the evidences of their comparative reputations in this country year by year. The appended table shows, so far as statistics are available, the quantities imported from various countries and the amounts manufactured at home, each year since 1877. The rapid decline since 1888 of imports of English cement from 66·1 to 19·6 per cent. of total imports, and the contemporaneous increase of the imports from Germany from 28·0 to 49·4 per cent., is a tale with a moral. The increase in the quantities in the "Other Countries" column since 1894 may be accounted for by the increased import of Danish and Swedish cement.

fact. As more attention is paid to cements and more care is taken in thoroughly testing and investigating them, the fact is growing apparent that, even though American Portlands are not always perfect, the chances of receiving a lot of imperfect cement are fully as great with the foreign as with the domestic article.

The testing of cements for use upon works is just as important as the testing of steel for use in bridges or boilers, and to the failure to give careful attention to this point is due in a great measure the slowness of American consumers to appreciate the value of American Portlands. Probably in no other country in the world, producing or consuming large quantities of cement, is the spirit of investigation in this direction so little apparent. While England has no national system for testing cements, still fully 75 per cent. of the cement consumed is thoroughly tested by experts, and the same may be said of Holland. France, Belgium, Germany, and Austria maintain government testing stations where cement, among other engineering materials, receives careful attention. In this country more attention has been given to the matter of late, but still enormous quantities of cement are consumed concerning which the consumer knows absolutely nothing except the brand on the barrel or sack. The writer has met inspectors on works who "did not believe in testing," and who professed to be able to tell all about a cement by feeling it or tasting it. Many consumers who do test their cement limit their tests to fineness and a few neat briquettes broken at seven days old; and, with these two tests as their only criterion, they place the limits of strength in their specifications as high as they dare. This fact, coupled with the keen competition among makers, is a sore temptation to over-lime their product beyond a safe limit. It is greatly to be hoped that the present dawning of the days of careful tests will overcome this danger.

The following summary of amounts produced in, and exported from, the various countries of the world is as nearly correct as statistics available will permit:

CEMENT PRODUCTION OF THE WORLD.

		Output. Barrels.	%	Export. Barrels.
1.	Germany	13,500,000	38.4	3,000,000
2.	England	8,300,000	23.7	3,500,000
3.	France	3,000,000	8.6	1,139,000
4.	United States	2,300,000	6.6	
5.	Belgium	2,250,000	6.4	1,500,000
6.	Russia	2,000,000	5.7	
7.	Austria	1,000,000	2.9	
8.	Italy	800,000	2.3	
9.	Norway and Sweden	500,000	1.4	100,000
10.	Denmark	400,000	1.1	
11.	All other countries (estimated)	1,000,000	2.9	
		35,050,000	100.0	9,239,000

The demand for Portland cement the world over is rapidly increasing. In all the principal producing countries the factories are overstocked with orders and hardly know how to fill them. European makers are not seeking the American market so anxiously, partly on this account and partly because they have to meet such fierce competition from the American factories. This fact, coupled with the increasing confidence in American brands, points toward a still greater diminution in imports from now on. The duty on cement is 8 cents per 100 pounds, or about 30 cents per barrel, and ocean freights amount to about 40 cents. The foreign Portlands must thus be produced at least 70 cents per barrel cheaper than at home to meet competition. Freights from our principal producing centers to New York are about 14 cents per barrel.

We have seen that England, though for years in the lead, eventually yielded first place in the Portland cement industry to Germany, with its more careful and systematic methods. The United States has entered the field in comparatively recent years, and now holds fourth place in volume of output. The quantities are increasing annually by strides, while even yet the domestic supply is only one-half the consumption. It seems quite probable that the foreign brands will

UNITED STATES PORTLAND CEMENT STATISTICS.

	Imports from England.		Germany.		France.		Belgium.		Other Countries.		Total Bbls.	Manufactured in United States. Bbls.	Consumed. Bbls.	% Made U. S.
	Bbls.	%	Bbls.	%	Bbls.	%	Bbls.	%	Bbls.	%				
1877											58,450			
1878											92,000			
1879											106,000			
1880											187,000			
1881											221,000			
1882											337.793	85,000	455.406	20.1
1883											472,864	90,000	462,864	16.0
1884	370,515	63.6	184,185	31.6	5,453	0.9	22,261	3.8	209	0.1	582,623	100,000	682,623	14 7
1885	270,356	46.8	267,800	46.3	1,451	0.2	35,073	6.1	3,461	0.6	578,141	130,000	728,141	20.6
1886	332,546	51.5	284,927	44.2	3,937	0.6	21,751	3.4	2,036	0.3	645,197			
1887	621,367	57.5	427,510	39.6	4,854	0.5	22,673	2.1	3.540	0.3	1,079.944			
1888	1,332,865	66.1	564,883	28.0	10,465	0.5	99,401	4.9	9.376	0.5	2,016,990			
1889	943,866	62.2	484,824	31.9	3,957	0.3	81,336	5.4	3.367	0.2	1,517 350			
1890	1,161,612	56 4	723,487	35.1	15,658	0.7	159,834	7.8	148	0 0	2,060,739	335.500	2,396,239	14.0
1891	1,336,858	47.6	922,007	32.8	10,364	0 4	533,927	19.0	4,663	0.2	2,807,819	454,813	3,262,632	13·9
1892	1,127,701	42.0	1,073,768	40.0	2,985	0 1	475.903	17.7	5.564	0 2	2,686,921			
1893											2,674,149	590,652	3,264,801	18.2
1894												798,757		
1895	806,884	26.9	1,299.914	43.4	22,837	0.8	708,875	23.6	158,880	5.3	2,997,395	990,324	3,987,719	25.3
1896	742,169	24.8	1,366,909	45 7	26,714	0.9	742,237	24.8	111,568	3.8	2,989.597	1,543,023	4,532,620	34·7
1897	460,592	19.6	1,160,905	49.4	32,124	1.4	645,780	27.5	48,619	2 1	2,348,020	2,304,300	4,652,320	49·9

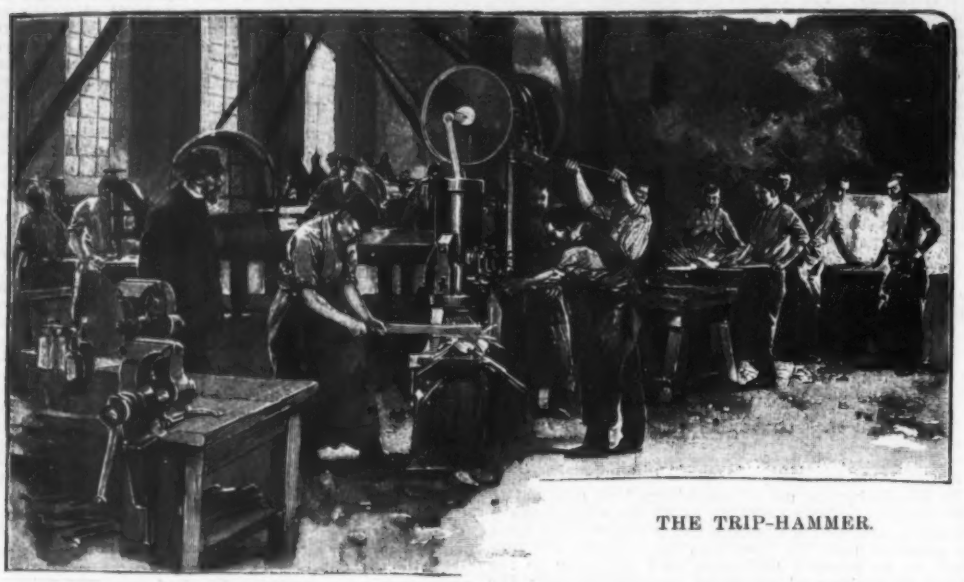
But the most significant fact is the steady and rapid increase in the proportion of manufactured to imported cements since 1891. That proportion should and undoubtedly will be increased still more rapidly in the future. For years the American makers have had a hard struggle against strong adverse prejudice. The prejudice was at first well founded, since the early attempts to produce Portland cement here met with little better success than abroad. But, once established, it has been very hard to live it down. Portland cements, fully as good as any from Germany or any other country, have been made here for several years, but Americans are only beginning to realize the eventually be practically driven from the market; but may we not aspire to even greater things, and hope that at no very distant date American manufacturers may, by their skill and ingenuity, so reduce the price, while maintaining the quality, that we shall see American Portland cements crossing the ocean and successfully competing with European brands in the markets of non-producing countries of Europe?

According to statistics supplied by Lord Brassey, the number of trained seamen in the British navy, apart from the reserves, is 106,000. France has 50,000, Russia 32,000, and Germany 25,000.

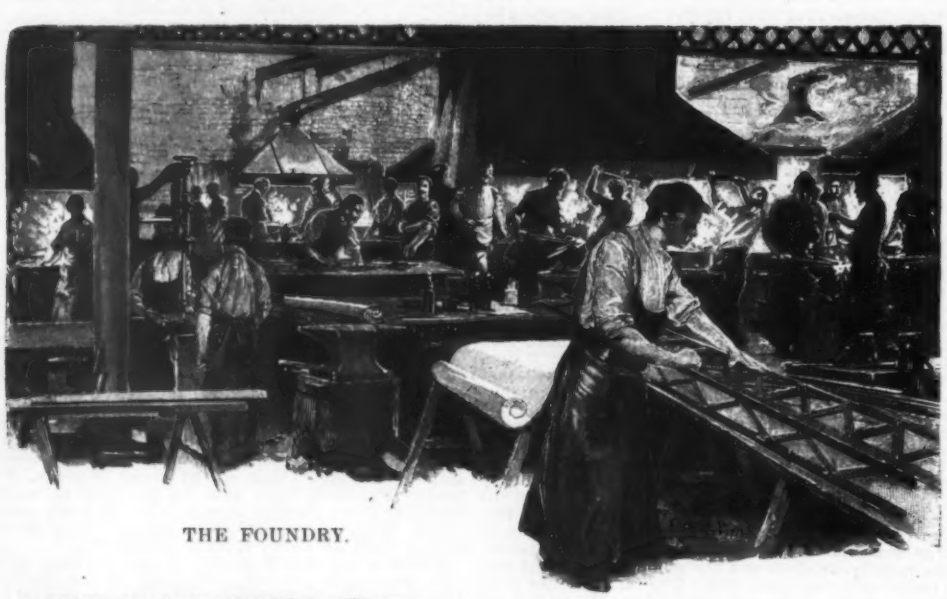
THE GERMAN BLACKSMITH'S ART.

TOWARD the middle of our century there began in France a revival of the art of iron working—an art which since the Rococo period had fallen entirely into decay and oblivion. This awakening call was re-echoed in the heart of a young German locksmith, named Eduard Puls. In 1861, this locksmith, hardly 22 years old at the time, opened a small shop in Berlin and endeavored unassisted to reanimate this art. As an apprentice he had diligently studied designing under Risopp, later completing his art-education while traveling through Southern Germany and Italy. He keenly felt the lack of individuality in the industrial works of his time. Fate ordained it that the task of repairing old iron work was repeatedly assigned to the young locksmith, and this it was that caused him to interest himself more and more in the nature of antique iron work, to imitate it and to endeavor to produce something similar. This ardent ambition caused prominent men like Ende, Sussmann-Helborn, Hitzig, and others to aid him and to encourage him by giving him orders.

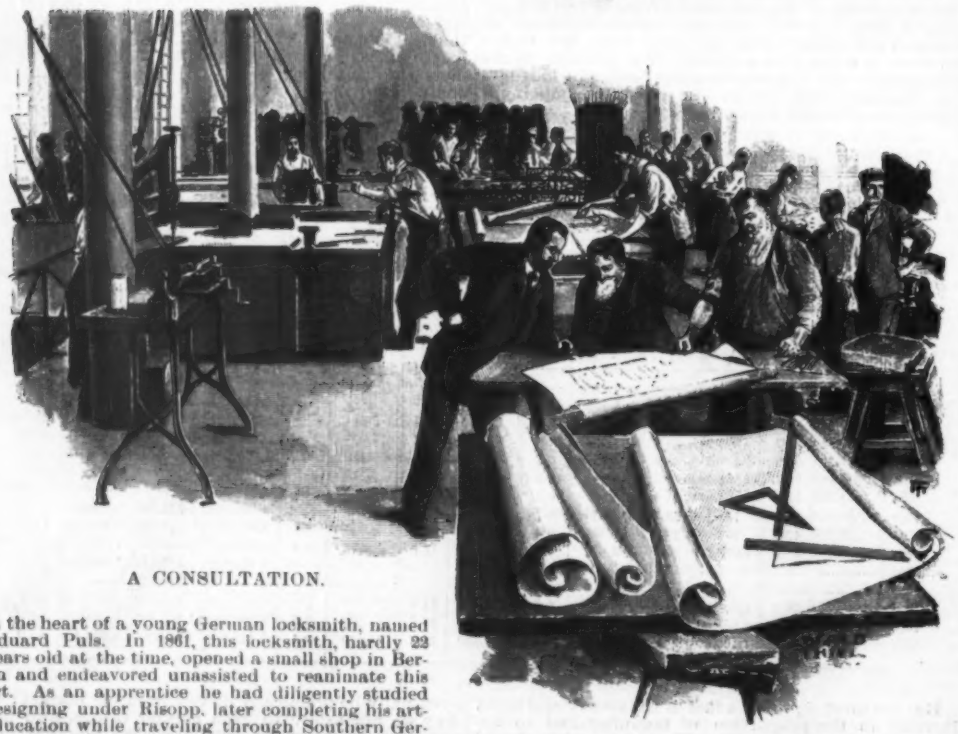
At that time, but few draughtsmen or locksmiths took kindly to such work. For the very elements for the work had first to be made. That, too, must be placed to the credit of "old Puls," from whose work the entire Berlin art-iron-industry now known the world over grew up. In his workshops he trained youths, who have become good master-workmen, and who can vie even with him. After thirty-five years of hard, honorable work, the old master was laid to rest on October 1, 1896, his work being still carried on by his sons.



THE TRIP-HAMMER.



THE FOUNDRY.



A CONSULTATION.

Hardly had the first works of the bold locksmith received due recognition and approval from prominent architects, when from all sides orders came pouring in, the execution of which carried the reputation of the firm far beyond Prussia.

The little locksmith's shop had developed into an establishment with a world-market for its products, and showed for the first time what it could perform at the Berlin Industrial Exposition of 1879. Prominent among the works there exhibited, evoking no small interest in artistic circles, and discussed at length in the press, were the enormous masses of iron, which, treated in a truly artistic spirit, formed the gates to the vestibule of the Berlin Arsenal. A contemporary journalist in describing this work said that "Cyclops seemed to have wrought and welded together these iron volutes; in their hands the material became plastic wax." Many a time the firm had to perform these Cyclopean tasks, the mightiest of which was the making of the great middle gates constituting the Eosander Portal of the royal palace. These gates are 7·50 meters (24·60 feet) broad and 10 meters (32·80 feet) high, the decorative cap alone being 3 meters (9·84 feet) high. Each of the gates weighs more than 100 hundredweight; the cap itself more than 8 hundredweight. This gigantic piece of iron work, which, by reason of its aspect of dignified repose as well its fineness of detail, captivates and astonishes the observer, surpasses in size the largest pieces of artistic iron work which have ever been wrought.

The Berlin Exposition made the name of Eduard Puls famous. Formerly only the building world had concerned itself with this man; now all the artistic circles of Berlin began to be interested in his works. Often ladies and gentlemen of the best society crowded about the anvils and forges of his workshops, in order to see for themselves how the tough metal became transformed under the hammer of the skilled smith into vines, flowers, foliage, or even charming or grotesque forms. Many of my readers would be astonished to find the black, sooty fellows who with rough, callous hands stretch, bend, and weld the glowing bars of iron, men of artistic minds who are fully conscious of the purposes they serve, and who can speak as understandingly of their task as, for example, a painter or sculptor of the art-work which is formed under his hands.

Passing through the workshops, in which 180 men are now employed, we first see a number of machine-tools for working metal. Perhaps many will raise the objection that here, where the artist's hand alone should rule, such machinery is out of place. This objection is overcome when we consider that these machine-tools perform only the mechanical work of drilling, riveting, etc., and thus facilitate the work. The artistic work of the smith remains the same.

INSPECTION OF WORK.

Nowadays, when almost every house is ornamented with iron work, more or less artistic, these appliances must be used in order to produce works of moderate cost. The pieces worked by these machines often show a uniformity not always desirable, and hence it is the task of different shops to give them the appearance of having been wrought by hand. At all events, machines such as those found in Puls' workshops merit our consideration as energetic fellow laborers of the smith.

Our glance first falls on a powerful trip-hammer, under which huge, glowing masses of iron that seemingly deride all hammering with an ordinary sledge, become transformed and remodeled. One of the workmen at the trip hammer turns and bends the huge lump of iron until, under the thundering blows of the downwardly rushing hammer, it has been changed to a polygonal or round pillar, or into any form that may please the smith's fancy. Here, in the broad ground-floor in which naturally all works are executed that require the application of greater power, we find forge placed against forge and glowing bars of iron projecting forth everywhere, so that we can hardly find a path for ourselves. We bend and stoop, but soon we come into a dense shower of sparks, beautiful in appearance but, nevertheless, not quite harmless.

In another spot we see angular or arched chests resembling "drums," on which, according to prescribed measurements, larger pieces, particularly staircase railings, balcony-trellises, and the like, are bent. We see, furthermore, machines that drill holes for screws and rivets; a machine that bores holes 3 cm. (1·18 inches) in diameter in the thickest plates; and finally a stamping machine with a gigantic flywheel, which machine, with the assistance of steel dies, presses patterns and the like into the iron. But I must mention one machine which is placed, not in the foundry, but in the ironshed in the yard. This is an iron-cutting or shearing apparatus that cuts its way through the toughest iron

bars and plates as easily as if they were some soft, pliable substance.

We now come to the machine-shop. Here is placed a steam-engine of 25 horse-power, which drives the machines in the various shops, the dynamos that provide electric illumination and the blast for the 31 forge-fires of the building. This blast consists of a powerful fan which blows air through a passage into the forge-fires.

A granite staircase leads us to the first story, where the pieces wrought below are assembled, riveted, and screwed together. Here may be seen, in an advanced state of completion, gates, trellises, railings, ornamental anchors, gargoyles, chandeliers, and candelabra. Here, also, are machines which are adapted to facilitate the work. In welding bars together it is of especial importance that the abutting surfaces should be perfectly smooth and plane—a task which the filing and polishing machines must perform. Were this work to be done by hand-files, much time would be lost and considerable expense incurred. In our visit to the shops we found, in addition to many smaller works, the fence for the Berlin National Memorial, the main doors for an abattoir, a bowered walk, and divers bronze trellises for the Hotel Bristol; all works of marked artistic value.

Finally we arrive in the second story, where chiefly flowers, leaves, armorial bearings, and the like are made, later to be welded to other pieces or to be riveted or screwed to gratings. In forming these leaves, flowers, and other ornaments, the individual elements are first cut out of metal after pasteboard designs, either when cold or red hot, depending upon technical requirements. Such work is intrusted only to the best workmen, for a certain creative talent is required to animate iron in this way, and to transform it into palms and oak twigs, wreaths of leaves, and nosegays, or into odd little figures and fabulous animals. Often roses are seen wrought from one piece in the most natural forms—a feat which not many years ago was considered impracticable; in the fishes, crabs, frogs, and snails often seen in Puls' wrought iron work the most exacting naturalist would take delight.

It cannot be denied that the smith now very often improves upon the designer. The latter often indicates in outline much that the smith works out in detail. Nevertheless, both designer and smith go hand in hand in order together to create as complete a work as possible. The plan of the architect cannot in itself be considered as the basis of a piece of wrought iron work; only the detailed drawing made by a practical draughtsman according to scale can serve as the foundation of the smith's work. The firm of Puls has its own draughting department in which all designs are redrawn. If we glance over the huge drawing books which embody the creations of the house for 36 years, we obtain a lively appreciation of the artistic evolution of the German blacksmith's art since its revival. In all countries, however, the work of the firm tells of the renaissance of this German art—an art which transmutes a base metal into a noble metal and breathes life into dead iron.

We are indebted to Ueber Land und Meer for the engravings and particulars, which are from the pen of Fred Hood.

CHANDELIER MADE FOR H. R. H. PRINCE HENRY OF PRUSSIA.

GRATING OF THE ENNO MONUMENT, IN MINDEN.

CANDELABRUM IN THE IMPERIAL INSURANCE OFFICE.

WROUGHT IRON GATES ORDERED BY COUNT BISMARCK-BOHLEN.

ELECTRICAL NOTES.

France is, after Germany, says Revue Pratique de l'Electricité, the nation that possesses the largest number of electric tramways. During last year alone, a total of 73 miles of new track was laid, or more than at present exists in the whole of England. Of the different systems in operation, 180 lines are on the overhead trolley, 8 on the underground conduit, and 13 are worked on the accumulator system. Our contemporary is not quite accurate in part of its statements. In saying that Germany possesses the largest number of tramways, it loses sight of the American continent, and according to statistics we published in January last, 150 miles of track were in operation at the beginning of this year, and, including the lines in course of construction, the aggregate was 400 miles.

A scheme has just been submitted to the Italian government asking for a concession to construct an electric railway of a total length of forty-three miles over the Great St. Bernard. The project, says The Financial Times, is being promoted by an English company just constituted under the title of the Great St. Bernard Railway Concessionary Company, and has been placed before the Italian government by Mr. J. B. Fell, engineer, of Turin, who intimates that he has informed the president of the Swiss Federal Council of the intention to seek, both in Berne and Rome, a concession for the building of the line from the Italian frontier to Martigny, in the canton of Vallais. It is proposed to adopt a third rail on the rack system, as used on the Mont Cenis line. The promoters of the railway intend to insure safety in working during the winter months by the adoption of precautions against the danger of snowfall and avalanches. The cost of construction and equipment of the railway, for which no subsidies are asked by the promoters, is estimated at £600,000.

Telephone statistics of Europe show an increasing demand for telephone apparatus. The following table, prepared by the United States consul at Chemnitz, Germany, shows the present number of lines and instruments:

Country.	Number of lines.	Instruments.	Inhabitants to each telephone.
Sweden	293	42,354	115
Switzerland	295	23,446	129
Luxemburg	57	1,356	160
Germany	534	131,577	397
Holland	31	7,900	615
Belgium	15	9,400	682
France	407	31,681	1,216
Austria	124	18,950	1,318
Spain	48	10,810	1,597
Hungary	36	8,458	2,168
Italy	54	11,815	2,629
Russia	53	16,050	6,988
Bulgaria	5	243	13,616
Roumania	6	337	16,042

Aluminum wire will be used for the transmission line conveying power from Snoqualmie Falls to Seattle and Tacoma, Wash. Contracts have been made for the supply of the wire—150,000 pounds—at prices that make it cheaper than copper for the purpose. The metal used will be nearly pure, being guaranteed to contain 99·30 per cent. of aluminum and not more than 0·25 per cent. of iron and 0·30 per cent. of silica. It will be alloyed with 1·50 per cent. of pure copper. This, remarks The Electrical Engineer, is the first large transmission to use aluminum, and marks an important step in electrical engineering; for while aluminum has been talked of for some time for this purpose, price or some other factor seems to have stood in the way of its practical use to any extent over long distances. For the first twenty miles the transmission lines will run over the same right of way. At Renton they separate, and one goes northwest about twelve miles to Seattle, while the other goes southwest about twenty-seven miles to Tacoma. At Renton there will be facilities provided for switching the Seattle circuit onto the Tacoma circuit and vice versa.

The limitations to the overhead trolley are now quite generally recognized. It has been found that it is difficult efficiently to transmit by means of the ordinary form of trolley wheel more than 150 amperes from the wire to the wheel without excessive sparking and loss. The speed at which a trolley wheel will stay on the wire, through section insulators, special work, and switches, is limited in good practice to not much over ten miles an hour, says Mr. Pepper in The Journal of the Franklin Institute. When the trolley stand and wheel are both designed for high speed and the line carefully constructed, it is possible to run on straight line work at a speed of about thirty miles an hour. Beyond this speed the tendency to throw the wheel from the wire, owing to slight obstructions on the trolley wire, is very great. If the wheel leaves the wire at this speed, it is almost certain to either break the trolley pole or bring down a large portion of the overhead construction. It is for this reason that experiments have been and are being tried to substitute a fixed conductor near the ground with a large surface contact for the overhead trolley wire for high speed and heavy currents.

A system of portable or field electric railway has been brought out in Germany with complete success. As described by a correspondent of The Boston Transcript, the track consists of easily transported rail frames made of two rails of the usual field railway profile and connected together by, say, five crossbars; the middle crossbar extends a few inches beyond the rails on either side, and to its ends is bolted an iron yoke or frame in shape of an inverted U, the top of which is high enough to be well clear of the cars. The overhead conductor is supported at the center of the upper horizontal part of the yoke; the yokes are placed closer together at curves, and at the sharpest curves it may be necessary to fit every rail frame with a yoke in order to keep the overhead conductor sufficiently near the center of the track. The generating station is fitted in the usual way with a dynamo, and two feeders are led from the station to one end of the track, one being connected to the end of the overhead conductor and the other to the rails. For running the trolley wire, a special truck has been devised. On it are a pair of ladders leaning toward each other, and between them on the floor of the truck is a reel containing wire, and at the top, where their upper ends meet, is supported a guide pulley. By means of this truck a long field line, it is found, can be run out in a surprisingly short space of time.

MISCELLANEOUS NOTES.

In France the annual consumption of matches is about 900 per head of the population. About 33,000,000 matches were made in France in 1897 and about 45,500,000 were imported. The state has a monopoly for the sale of matches and tobacco. The sale of matches in 1897 realized a profit of about £800,000.

We hear a good deal about the annoyances of failures of electricity supply from central stations, but little is said of the troubles and dangers incident to a failure of the supply of gas, says The Electrical World. In Richmond, Va., a few nights ago, the breaking of a large gate valve in a gas main left the greater part of the city without gas shortly after midnight. Although the superintendent of the gas works soon discovered the cause of the trouble, he feared to turn on the gas again until the next morning, as it would have escaped from jets left burning and probably caused asphyxiations and explosions. A curious sequence of the failure was that the morning newspapers, which use linotype typesetting machines in which the metal is kept melted by a gas flame, appeared the next day with their pages set with such varieties of hand type as they could find at short notice, and most of the late news omitted.

The United States Life Saving Service at the close of the fiscal year covered by its latest report, June 30, 1897, embraced 259 stations—189 on the Atlantic and Gulf coasts, 55 on the coasts of the Great Lakes, 14 on the Pacific coast, and 1 at the Falls of the Ohio. Three hundred and ninety-four disasters were reported as having occurred during the year to documented vessels, in which 3,737 persons were exposed, 42 lives were lost, and $1,998,930 of property out of $7,107,825 was lost. There were also 305 casualties to undocumented craft—sailboats, rowboats, etc.—carrying 706 persons, 11 of whom perished, and in which $39,465 of property was lost. Five hundred and eighty-seven shipwrecked persons received 1,082 days' relief at the stations. The number of disasters is the largest reported in the history of the service, yet the number of vessels totally lost is the smallest since 1879, when the scope of the service was much less extended.

"Porto Rico," says The Lewistown Journal of recent date, "produces, under ordinary conditions, between 50,000 and 60,000 tons of muscovado sugar. This is brought out in the old-fashioned way, such as was in use in Cuba ten or fifteen years ago, and tests by the polariscope only about 87 to 91 per cent. By the centrifugal method, now in use at Cuban plantations, the output of Porto Rico would be increased by about 10 per cent. under present conditions, and when the balance of the arable land is placed under cultivation the crop will readily reach 100,000 or 150,000 tons. Cuba's annual output is from 1,000,000 to 1,100,000 tons of hard-grained, brown sugar, the bulk of which is sent to the United States. In Cuba, however, the quantity of arable land not under cultivation is even proportionately greater than in Porto Rico, so that under fair conditions an annual crop of 2,000,000 tons is a conservative estimate."

"Although there is not much talk about it in the newspapers, the construction work in progress on the Panama Canal is on a scale of magnitude which will bring the enterprise to a successful issue," said Mr. B. L. Hewson, of the Isthmus of Panama, to a Post reporter. "There are now over 4,000 men employed on the canal, and the work is being done in a thorough and scientific fashion. Had the first company proceeded as carefully as the present one is, the canal would have been in operation long ere this. The canal company owns the Panama Railroad, which runs across the isthmus, but the active management is in other hands. All the officers of the road and higher employés are Americans. It is a broad gage road, 47 miles in length, and of recent years has done a heavy business. Its passenger tariff is the highest in the world, as the charge for taking one over the route is $20 in gold, or almost 50 cents per mile."—Washington Post.

There is a new law on the statute books of Pennsylvania which ought to have a wide circulation. It is "An Act for the Encouragement of Forestry." This law takes the best means possible to encourage owners of land to preserve and propagate timber trees, for it allows a reduction of taxes to the owner of forest land which comes up to certain requirements of the act. The first man to take advantage of the new law is an Allegheny County farmer, Mr. Tenner, of Lee Township. As told by The Pittsburg Chronicle-Telegraph, Mr. Tenner has obtained from the county commissioners a reduction of $22.50 on his taxes for complying with the provisions of the law. It is rather remarkable that the second county in the State in point of population should be the first to pay a bounty for forest preservation under the new law, but such is the case. The landowner who preserves his woods not only gets this immediate reward, but the increasing value of the trees will make a further and larger profit for him eventually.

The shell concrete pavements of Macon, Ga., are attracting considerable attention at present. The material used is a shell limestone similar to the coquina of which buildings were constructed at St. Augustine while it was a Spanish colony. There is a bed of this stone about thirty miles from Macon, which was discovered during the construction of the Georgia Southern and Florida Railroad some years ago. Part of the roadbed of that railway was made of it, and it hardened into such a durable form that several carloads were brought to the city and laid about the freight station, where it resisted the wear of the heavy traffic unusually well. After it had been in service for four or five years, the city paved a street having one of the heaviest grades in Macon with it, and this first street gave such satisfaction that several more have since been paved in the same manner. About 35,000 square yards are now in use and petitions for 10,000 yards more are on file. The stone is crushed and laid on the subgrade excavated to receive it; the layer is about seven inches deep at first, and is consolidated by a fifteen-ton steam roller to a thickness of six inches, being sprinkled at intervals. On heavy grades a gutter is formed by mixing cement with the stone. The pavement costs from 50 to 60 cents a square yard, which includes crushing and labor.—Engineering Record.

SELECTED FORMULÆ.

Chemical Destruction of Weeds.—Everybody knows how troublesome a weed is the common charlock (Sinapis arvensis), how rapidly and completely it takes possession of a field in which it is allowed to obtain a footing, and how difficult it is to eradicate. At the last meeting of the French Society of Agriculture, M. Aime Girard, the celebrated agricultural chemist, announced that cereal fields could be readily freed from the weed, without the least damage being done to the grain, by treating them with a 5 per cent. solution of sulphate of copper. The explanation appears to be that the salt is absorbed by the tissues of the charlock, whereas it does not affect the difficultly permeable cuticle of wheat or oats. A drop of water deposited with suitable precautions on an oat leaf retains its spherical form, and with a little care may even be removed without the leaf being moistened.

On the other hand, a drop placed on a charlock leaf forthwith extends, and enters the tissues. The same thing happens when a solution of sulphate of copper is employed. Hence the charlock is poisoned, and perishes at once, while the grain escapes. This seems a very simple and cheap method of weeding a field of wheat or oats. If, however, M. Bernard, who took part in the discussion of M. Girard's paper, is not astray in his conclusions, an even simpler and cheaper plan may be pursued by using sulphate of iron instead of the copper salt. He used a mixture of sulphate of iron and water, consisting of 20 or 30 kilogrammes of sulphate to the hectoliter of water, and found that from fields sprinkled with this liquid charlock disappeared entirely, the cereals being uninjured.—Revue Scientifique.

Inks for Hand Stamps.—The following formulæ are taken from Pharmaceutische Manual of Eugen Dieterich, and which we print in answer to the frequent inquiries of correspondents asking for one or another of the inks. Dieterich divides his inks into three classes, namely: Inks in which an insoluble coloring matter is suspended in an oily vehicle, oil soluble anilin inks, and glycerin inks. The first class should be labeled "Shake before using."

INKS IN WHICH THE COLORS ARE SUSPENDED.

1. Ultramarine blue:
   - Ultramarine in impalpable powder... 1 part.
   - Olive oil... 3 "

   Mix.
2. Dark blue:
   - Ultramarine... 1 part.
   - Paris blue... 2 "
   - Olive oil... 17 "
3. Green:
   - Verdigris, in fine powder... 5 parts.
   - Oleic acid... 1 "
   - Olive oil... 5 "

   Mix the verdigris and oleic acid, and let it stand 15 to 20 minutes, then add oil.
4. Red:
   - Vermilion... 2 parts.
   - Olive oil... 3 "

   Mix.
5. Black:
   - Lampblack (gas black)... 3 parts.
   - Olive oil... 17 "

OIL SOLUBLE ANILINE INKS.

6. Red:
   - Bordeaux red... 15 parts.
   - Aniline scarlet... 15 "
   - Crude oleic acid... 50 "
   - Castor oil... 950 "

   Mix.
7. Blue:
   - Aniline blue... 3 parts.
   - Oleic acid... 6 "
   - Castor oil... 94 "

   Mix.
8. Blue-black:
   - Aniline black... 5 parts.
   - Oleic acid... 6 "
   - Castor oil... 94 "

   Mix.
9. Green:
   - Aniline blue... 25 parts.
   - Aniline lemon yellow... 15 "
   - Oleic acid... 50 "
   - Castor oil... 950 "

   Mix.
10. Violet:
    - Aniline violet... 3 parts.
    - Oleic acid... 5 "
    - Castor oil... 95 "

    Mix.

In preparing these inks rub the aniline (oil soluble) to perfect smoothness in oleic acid, then add the oil, little by little, with constant rubbing. After incorporation of the whole of the oil, heat the mixture, under constant stirring, to about 45° C. (167° F.)

GLYCERIN INKS.

The water soluble anilines alone are used in these preparations. The vehicle is as follows:

- Distilled water... 10 parts.
- Wood vinegar... 10 "
- Alcohol... 10 "
- Glycerin... 70 "

Mix.

To make any desired color of ink add the following in the proportions named:

- Blue—1 B water blue... 3 parts.
- Violet—3 B methyl-violet... 2 "
- Red—I fuchsin (diamond)... 2 "
- Green—D aniline green... 4 "
- Black—E deep black... 3 "

A brilliant bright red is made by adding 3 parts of BBN eosin to a vehicle made by omitting the acid and adding 10 parts of water in its place.—National Druggist.

INEBRIETY AND ITS "CURES" AMONG THE ANCIENTS.*

WILLIAM L. BROWN, L.R.C.P., L.R.C.S., Edinburgh.

THE conditions among the ancient drinkers were pretty much the same as those met with to-day. The ancients were familiar with the consequences of excessive drinking. The same results received attention at the hands of the ancient philosophers and physicians. One can hardly help noting, however, that in their philosophy total abstinence took a very subordinate place. They aimed rather at promoting a physical condition which fitted the drinker to indulge at will without harm to himself, they tried to avert the negative chemiotoxic influence of wine, to produce in the drinker "immunity" from the effects of alcoholic poisoning, and, failing that, to remedy the unhappy conditions which followed over-indulgence.

Ancient physicians when called upon to treat these cases divided their remedies into two classes:

1. Those administered before drinking began.
2. Those required after the debauch.

In the first place, they tried "to prevent the fumes of the wine from rising upward to affect the brain," and secondly, "to eliminate or drive out the 'fumes' of the wine either by the urine (diuretics) or by the bowels (laxatives)." This we learn from Galen, who, in his "Composition of Medicines," gives many prescriptions on these lines derived from all departments of pharmacological knowledge and from every kingdom of nature.

One of the simplest and most primitive ways of preventing evil results from drinking was the custom of diluting the wine with water and flavoring it with ingredients having an aroma more or less delicate and pungent, which were supposed to prevent the wine from causing intoxication, such as ginger, pepper, spices, and cheese.

The Romans mixed their wines with honey, and a kind of oxymel was prepared by mixing wine with sea salt, vinegar, and oil of roses. The medicated wines of which Hippocrates has given so detailed an account contained "horehound," "squills," "myrtle berries," and many kinds of essential oils. They were prepared for medical purposes only.

Both Greeks and Romans used to mix their wine with "resin" (Plut. Symp., v., 3, 1) and with sea water, probably to enable it to keep better. The resin wine is still the favorite drink among the Grecian "hoi polloi" of to-day. The salt water, according to ancient therapeutists, was supposed to promote digestion and to keep the wine from going to the head.

Wreaths and crowns were considered of great medical importance for preventing and palliating drunkenness, and two Greek physicians wrote treatises on their medical virtues (Pliny, xxi., 3), the most popular form, both in Greece and Rome, especially for convivial meetings, being the "wreath of roses." At first only woolen fillets or "head bands" were used to prevent intoxication, but afterward leaves and flowers were made into garlands and worn at feasts. These were constructed of myrtle leaves, cabbage leaves, ivy, violets, roses, and such like. Pliny tells us the favorites were the myrtle and the roses (Pliny, xxi., 31). The ointments and perfumes were brought in with the flowers. When more than usually merry the ancients even went the length of decorating the bottles and glasses as Virgil tells,

> "Tum Pater Anchises magnum cratera coronis
> Induit, implevitque mero."

Then Father Anchises (as chairman) puts the wreath round a large jar and fills it up with wine." Sometimes they encircled not only the jars, but their heads and even their whole bodies with these "safety wreaths."

Dress formed a very important item in these drinking scenes. The heads were carefully decorated with various forms of animals' skins, and the ladies attached great importance to the kind of dress and jewels they wore. The "amethyst" hue was the "drink-resisting" color. The ladies wore amethystine clothes and jewels, and the amethyst formed the favorite ornament for drinking vessels, right up to the time of Nero, who seemed to have a prejudice against them (Suet., Nero, 25). The amethyst formed an artificial means of preventing intoxication, or of curing it, by hanging it round the neck, or fastening it round the body, or else by taking it internally. It was a pharmaceutical article at that time, said to act by its "hidden properties."

Nowadays there are many who recommend a vegetarian diet as the best preservative against the snares of alcoholic liquors. The historical origin of this idea comes from ancient Egypt. Herodotus informs us that at Egyptian tables rich, stimulating articles were supplied to excite the palate before drinking, and especially boiled cabbage, which was reputed to carry off wine from the stomach if eaten before the drinking began. As a preparatory dish, cabbage long held its place in Egypt. Aristotle recommends "cabbage, olives, and sweet wine" for the prevention or alleviation of drunkenness. Besides cabbage, Pliny recommends "leeks or porret (Bk. xx., c. 6) for allaying thirstiness and dispatching the fumes which cause drunkenness." From him also we learn that "The Greeks hold that colewort is contrary to wine and a very enemy to vines, and more particularly if it be taken fasting or at the beginning of a meal, and preserveth a man from drunkenness; and eaten after drink it ridgeth away the fumosities of the brain and bringeth him to be sober." The Germans nowadays still keep up the custom of eating cabbage before and with their deckel glass of beer in the form of the juicy "sauerkraut."

The bitter principle of certain vegetables was recognized centuries before it could be isolated by chemical process, and it played a great part in the prevention and treatment of drunkenness. This principle is still used; but the origin of its employment for quenching the fumes of wine is lost in the vista of antiquity.

This important group included in ancient times such things as wormwood in raisin wine, bitter almonds (either whole or in the form of an emulsion), peach stone kernels and leaves of the peach tree, hops, crocus, "bitter roots and mullet." Those who held that drunkenness arose from the acid part of the wine gave anti-acids and bitters to cure it. The action of "bitters" was then, as now, a therapeutic puzzle.

Hops and crocus, peach stones, and many bitters acted very well, but Dioscorides (Book i., c. 25) showed that absinthe, though a bitter stuff, actually caused drunkenness when given in raisin wine.

The action of the essential oils was specially represented by the rue plant. Powdered rue in water was praised by Pliny. "Is a man disposed to drink freely and to sit square at it? Let him before he begin, to take a draught of the decoction of rue leaves, he shall bear his drink well and withstand the fumes that might trouble and intoxicate his braines." (Pl., Bk. xx., c. 13, p. 57). Here permit me to illustrate the influence and importance of Pliny on Saxon learning, and consequently on our popular medical beliefs. In Sextus Placitus, who was the first medical compiler of Pliny, and whose works formed the first standard text books translated into the Saxton tongue (B. M. MS., Harl. 5294; Bod. MS., Hatton, 76), we learn that the herb rue acted on sore and swelling of the eyes, was a remedy for stupor, for dimness of vision, and for headache—all symptoms of intoxication.

Anglo-Saxon drinks are described in the Beowulf and also in the Anglo-Saxon poem of Holofernes. These people did not restrict themselves merely to mead and beer. Large importations of wines were made from Spain, Italy, and France. Olaus Magnus, in his "Historia de Gentibus Septentrionalibus," states that these northern people "sweat in their contentions who shall at one or two or more draughts drink off a huge bowl."

The Saxon doctors never thought of treating drunkenness or inebriety as a disease, simply because they only treated observed symptoms. One looks in vain through Saxon literature for any such word among lists of diseases or among the remedies they employed. The symptoms they treated were swelling of the eyes, unconsciousness, dimness of vision, headache, bloatedness, and such like. For these the Saxon wise women had their charms, their potions, their unguents, mostly derived from Pliny through Sextus Placitus and Marcellus. They also treated their cases by operation, principally bleeding and blistering, pinching, and other barbarities. In Sextus Placitus we read that the herb rue acted very well upon "sore of the eyes" and swelling of the eyes, and was a common remedy for dimness of vision and for headache. All this and much more is taken from Pliny and handed down to us through our Saxon fathers, and they are remedies which may yet be found employed by the wise women of to-day who inhabit those remote and unsophisticated districts where the remains of the purest Saxon is still the mother tongue of the populace. "If you eat the flower of rue," says Pliny (25, 13), "it is a good preventive of drunkenness, driving out the wine by the urine and preventing it from being absorbed." Quite a modern explanation of the diuretic properties of oil of rue. Milton, in his "Paradise Lost," mentions the old Saxon belief in the effect of rue on the optic nerve:

> "Then purged with Euphrasy and rue
> The visual nerve, for he had much to see."

The gin drinker of the present day sometimes still drinks "rue gin," probably as a preventive of the ocular effects of gin drinking, since gin in itself is reputed by its votaries for its diuretic properties. Aelian mentions myrtle seeds, verjuice, crab apples, medlars, mulberries, asparagus, origanum, thyme, as well as rue, as suitable for mingling with wine to prevent temulentia. Nutmegs were recommended because they close up all the pores and drive out wine by the urine.

This was the ancient way of expressing the diuretic and antiseptic action which most of the essential oils possess. And here we may remark in passing that the treatment of drunkenness by diuresis was practiced long before Dr. Alexander Peddie's time, or before the liquor ammonium acetatis was a pharmaceutical preparation.

Perhaps the most curious of all the remedies used by the ancients to prevent the effects of wine came from the mineral kingdom. Theophrastus says that great drinkers, when they drank for wager, used to take the powder of pumice stone before setting to. Concerning this, Pliny observes that they must "quaffe lustily indeed, for unless they be filled with drinke they are endangered by the aforesaid powder." It is remarkable that in the poetry of the Norsemen from the earliest times, say up to the thirteenth century, which Prof. York Powell has classified and translated, a similar advice is given in these words: "Whenever thou drinkest ale, take earth's strength as antidote, for earth acts against ale, fire against sickness, oak against binding of the bowels, the corn ear against witchcraft, the rye against the biting sickness, runes against charms, earth drinks up floods." The mountaineers in some Alpine regions have still belief in the efficacy of certain kinds of sandy soils and use it for the same purpose as did the ancient Romans.

In Pliny's time the application of the gold cure was simplicity itself. "Gold," says he, "that was brought in a place to do a shrewd turn, wash it well and sprinkle those to be cured with the water." In Pomet's time, the seventeenth century, "its use gave a great opportunity to mountebanks to cheat with impunity. This sort of cheat is what generally succeeds best, for patients are prepossessed in favor of such medicines as carry great names and have a specious appearance. It is cried up for a miracle, and the effect is attributed to the gold." The Arabians first administered gold internally, thinking, as many vainly imagine nowadays, that it must have great virtues, though in all probability it has really none. Even in reconstructed forms of administration, it is a mere physiological absurdity.*

Perhaps the simplest and best remedy history has yet discovered, and the one most commonly used at the present day, is one referred to by Pliny. "Passing good it is," says he, "to drinke faire water other whiles between. In like manner such as use ordinarily to be drunk and are lightly never sober shall not do amiss to take a good draught of cold water presently upon their liberal pouring in of wine, for it will forthwith dispatch and discuss those fumes which cause drunkenness." (Bk. xxiii.) Some waters had more effect than others in achieving this result. Salt water was supposed to aid digestion and keep the wine from going to the head. There was an Arcadian fountain whose waters were reputed to make those who drank it so abstemious of wine that they could not even bear the smell of it. "Let a man," says Pliny, quoting from Varo, "drink of the Lake of Clitorius, he shall take a misliking and loathing for wine." (Bk. 31, c. 2.) Galen recommended barley water (tisane), wheat water (sorbilio), and toast water to prevent the stomach from being too much upset. This water cure has recently been revived. "He that drinketh shall thirst again," "but," say some doctors, "he that drinketh of the water that I shall give him shall never thirst." Such would fain have us believe they have discovered springs from the Arcadian fountain in some natural mineral waters with which the pharmaceutical market is so well stored. As to the efficacy of mineral and effervescent waters in the treatment of over-drinking, the same differences of opinion exist as were called forth by the learned round the shores of Lake Clitorius.

When the appetite for drink began to pall, the ancient Greeks and Romans provided themselves with articles which stimulated the palate. Horace mentions the African snail and onions as fulfilling the purpose for which thirsty souls now employ the anchovy to assist their cloyed appetite for liquor.

> "Tostis marcentem squillis recreabis et
> Afra potorem Cochlea."

("You will stimulate anew the clogged powers of drinkers if you give them roasted onions and African snails"), which the Romans esteemed as great delicacies. Perhaps it is for similar reasons that, in the Burgundy districts of France, notably the Côte d'Or, the escargots are regarded with so much favor. On the Continent these appetizers are greatly in vogue.

In modern days, in nearly all English-speaking countries, the red herring or salt herring finds favor with the surfeited drinker. He rejoices in hardened salted fish, like the "Speldern," which, in Scotland, has now almost become extinct before the more luscious and aristocratic close fish from Bervie.

On many an English and Scotch bar these appetizers occupy a prominent place in company with olives, shrimps, prawns, sardines, whelks, leberwurst, and the savory saveloy.

Failure seems to have characterized all these prophylactic cures. Not all the cures suggested by all the ancients prevented them, male and female, from becoming intoxicated. Theophrastus mentions a typical case of an Egyptian lady, of which I give the following translation:

"I remember," he says, "a certain woman in Egypt, who, being drunk by a large amount of Cretan wine, became immoderately mad, and afterward so lascivious that she immediately embraced and kissed every man she met. From laughing and singing, she went over to rage and fury, and wanted to fight everybody, and so strife and confusion was the consequence. All who were in the same house with her took precautions against her, because they were frightened of her. Then she got very sorrowful and lamented a great deal, invoked her dead relatives and friends in a plaintive song, until she was overcome by sleep, by which she was altogether cured of her drunken fit." Nothing could surpass the accuracy of this description of the action of alcohol in its different stages.

The ancient physicians aimed at curing the temulential condition by treating the stomach (apepsia), the head (crapula), and removing the morbid product which interfered, as they thought, with the action of the vital spirit, but which modern pathology regards as "an excess of excrementitious matter." "The continuous ingestion of an enormous quantity of liquid, much more substantial than water, which fails to turn on the renal taps sufficiently to insure its own rapid excretion."*

It is certainly curious to consider how much time and energy our ancient confrères devoted to the endeavor to harmonize their clinical observations with the curious systems of pathology which existed up to the last century. Drunken hilarity was the effervescence of acids and alkaline spirits in the ventricles of the brain. Aristotle said, "One thing seems to the drunken man to be many, because his vision was at no time at rest on the same subject." The tendency to lacrymation, the "Greetin fou" stage, was due to the head being filled with a pipuitous humor which the fumes of the wine made thinner. The thickness of speech was due to the absorbency of the tongue and to the mind suffering in drunkenness.

The treatment was perhaps a good deal better than the pathology, consisting as it did, for the most part, in an attempt to bring about a dislike for wine, to eliminate it from the system as quickly as possible by emetics, diuretics, or purgatives, or to act upon it with drugs which possessed "hidden properties."†

Loathing was said to be produced by such things as wine in which an eel had been suffocated, or into which boiled sea grapes had been put. If the eggs of the night owl were given in wine it produced this loathing (Pliny, xxx, c. 5), and a "Mullet killed in Rubellium," or two eels, or a grape fermented in wine had the same effect (Pliny, book xxxii, c. 10). If the lion's stercus was put in wine, it created this feeling of disgust (Albert Magnus, "De Animalia," book xxii). Democritus pointed out that the thin humor which flows out of the sarmentus (a kind of twig), when given to a man without his knowledge, destroyed the desire for wine. The water of the Arcadian fountain, already mentioned, caused even the smell of wine to become nauseating. A Scythian writer gave a good prescription if it were only practical. When asked how to make men "total abstainers" (invinius), Anacharous replied, "If the motives of drunkards can be put before their eyes, it is as if that were done which Cicero advised in the case of an angry man, that is, to put a looking glass before his face." What a list of stupid things could be mentioned as having been seriously put forward to create a "loathing for wine," even if one only confined one's self to recent suggestions.

What may be called the first aid in the treatment of temulentia consisted in invoking emesis by the administration of lukewarm water and vinegar, putting wet cloths round the head, and applying cold douches to the genitals; a proceeding still in vogue among sailors, who sometimes apply it very vigorously. Galen recom-

* Read before the Society of Inebriety, of London, England, January 13, 1898.—From the Quarterly Journal of Inebriety.

* For other pretentious drink cures, see Chemist and Druggist, January 30, 1897.

* A. T. Wilkinson, Lancet, December 11, 1897, page 1520.

† Galen, "De Medicine," Book III, c. 108.

mended sleep as "Nature's sweet restorer," in these cases, after which his directions are, "Wash him in a bath of fresh water." This was Mr. Weller's method of dispelling the feverish remains of a previous evening's convivialty and of making himself feel less like a "walking brandy bottle" next morning. Homer records that Circe was found by Jason's companions bathing her head in cold water. Hippocrates gives very full and careful directions for using the bath in such cases.* This was the popular treatment in the time of Persius, who writes:

"Hæc sancte ut poscas, Tyberius in gurgite mergis
Mane caput bis, terque, et nocte fulmine purgas."

"The boon to ask with grace in Tiber's wave you plunge,
And by the morn's immersion a night's debauch expunge."

You will remember how his treatment has found favor among all classes of society, represented in Martin Chuzzlewit by young Mr. Bailley, who informed his friend Poll Sweedlepipe on a memorable occasion that "Arter late hours nothing freshened up a man so much as an easy shave." It would scarcely be believed that the cold bath treatment was for long in abeyance and in disrepute. In the early seventeenth century, Sir John Floyer advocated in his "History of Cold Bathing" a recurrence to a useful ancient practice, which has held its ground ever since.

The object of all the treatment was to "repress" the vapors. Galen mentions many means of doing this. In his "Composition of drugs" (Book II) there is a chapter on drunken headache ("De Dolore Capitis ab ebrietate"). Most of the preparations used are those already mentioned, ivy, cabbage, fomentations, frictions with unguents, and the application of cabbage leaves to the head. Patients were given barley water (tisane), wheat water (sorbilio), bread steeped in water (panis ex aqua), lightly boiled eggs, lettuce, and juicy herbs, which were refreshing and cooling. Lentil water and the modern pease pudding were highly recommended. If these did not produce sleep, the hot bath was resorted to, frequently assisted by the hot douche.

The main objects aimed at were to aid the stomach, to produce sleep, to relieve headache and nervous symptoms. The shampoo was freely resorted to, and the head was rubbed with sweet smelling unguents and oils, and stimulants were administered. It was customary in ancient times to administer what is now called "a hair of the dog that bit you." I have been unable, though I have searched long, to discover the origin of this phrase in connection with the drinking customs of the ancients. It was certainly held among the Greeks that "if you get drunk to-day, drink again to-morrow to put yourself right." The Greeks had a notion† that they could drive out wine by wine (Oino ton oinon Exelaunein), or kill drink by drinking (Kraipalen Kraipale). The prescription perhaps arose from the fear that the ancients had of dog bite. Ancient works abound in prescriptions for dog bite, most of them being directed to avert the patient's attention from the injury and to administer a stimulant. Pliny says that the Romans had great faith in the efficacy of drinking burnt hairs taken from the tail of the animal that inflicted the bite, but the hair was always given in a good bumper of the best wine. The death of the dog was insured by requiring an infusion of its liver to be made and administered, a practice adopted by the Egyptians, Indians, Chinese, as well as the Romans. But I can go no further. I do not know how this expression has connected itself with curing inebriety, or how, or by what means, the expression first became current in this sense.

Stimulation formed a part of the ancient treatment of temuletia; the wine administered varied in strength and quantity according to circumstances. In Italy Sabine wine was preferred as the proverbial "hair of the dog." In England you will remember Christopher Sly's request when he awakened from his debauch:

"For God sake, a pot of small ale!"
(Taming of Shrew, Induction, Scene II.)

Indulgence in small ale was the favorite mode of curing the "horrors" in early England, and served to discharge the friendly office assigned by more cultured age to brandy and soda to slake those parched throats and to soothe those shaken nerves that follow over-devotion at the shrine of Bacchus. Modern drink doctors express contempt for all these, and speak of such stimulation as treacherous and false. They prescribe instead such things as columbo, aromatic spirits of ammonia, compound tincture of cardamoms, as the pick-me-up. But still it is stimulant treatment. In former days the Bacchanalian students of St. John's, Oxford, improved upon this treatment, and had a saying, "Better burn your coppers than drown them," as a reason for drinking a wine-glassful of Worcester sauce the following morning as a restorative.

Our country has played a vigorous part in imposing such restrictions, for it appears that in the Christian ages, and in Christian countries, the custom of partaking of alcoholic liquors grew to such an extent that canonical regulations had to be laid down to check it at a very early period. Probably the first liquor law of this country was that canon of St. Gildas the Wise (latter half of sixth century) which, at the close of the sixth century, sent the drunken monk supperless to bed. St. David was still more severe. He imposed three days' penance for the first offense and forty days if it were repeated. Theodore of Canterbury (668–693) extended the law to laymen, who got fifteen days' penance for drunkenness. From this to the principle of prohibition was but a step. The Saxon King Edgar (959–971) instituted it by reducing the number of alehouses in the villages and instituting the custom of pegging the huge drinking cups then in use. He made it a penal offense for any one to drink beyond the peg. This "drinking to the peg" was not everything that could be desired by the rigid prohibitionists of that time, and was so unsuccessful in the case of the priests that St. Anselm (died 1079) took a stand and forbade priests either to go to "drinking bouts" or to "drink to pegs." A further development of this took place in King John's reign, when the Scot Ales or Shot Houses were interdicted.

In the fourteenth century prohibition took the form of a revival of the Sumptuary Laws,‡ derived in part from the austere and injudicious theory of religion disseminated by the clergy. These laws tended to render all increase of general comforts odious under the name of "luxury." Almost everything was regulated, even the expenses of the table (37 Ed. III., repeated 38 Ed. III.) and the dress of the people. These attempts to restrain what cannot be restrained continued down to the eighteenth century, and have not yet been wholly abandoned.

The Assize of Bread and Ale (Henry III.) was in a sense a form of prohibition. Any brewer, baker, or tippler breaking the Assize of Bread and Ale to be fined (13 R., 2 c. 8; Lambert, 459). Sometimes the offender was punished corporally.

Other prohibitive measures were found in ignominious and disgraceful treatment meted out to inebriates. The corporations in those early ages had far more extensive power of dealing with drunkenness then they have at the present day, and they sought out many strange inventions to cure the drunkard. The corporation of Newcastle invented a jacket by taking a barrel with one end knocked out, placing the inebriate's head through a hole in the other end and compelling him to promenade the streets like a man in a circular sandwich. Besides this they used the filthy hurdle to drag the poor creature through the open sewers and cesspools of the town. Public ducking of offenders in dirty water was much in vogue four centuries ago. A newspaper describes such an event in 1745: "Last week a woman that keeps the Queen's Head alehouse at Kingston in Surrey was ordered by the court to be ducked, and was accordingly placed in the chair and ducked in the river Thames under Kingston Bridge in presence of two or three thousand people." The ducking stool or "cock stule" was used for drunken women even in this century. Jane Curran was punished in this way not more than eighty years ago at Leominster (N. and Q., Ser. II., vol. ii., p. 295). It was also used at Kingston on Thames in 1738. In James I.'s time the stocks was a favorite punishment, and in late days many drunken people, among whom we may mention the immortal Pickwick, were wheeled into the pound, to await there the filthy tokens of the playful disposition of the English many-headed. This might also be called the Filth Treatment of Drunkenness.

Early closing was first tried in Edward I.'s reign to prevent "excessive drinking and its noxious effects." Laws were passed to secure good ale for the public and the punishment of those who sold inferior or adulterated liquors. Ale conners or tasters were appointed by many corporations to see that the ale was good, and the brewer had to swear on the Blessed Evangelists to "brew good ale and wholesome so far as ability and human frailty permits."

Fines for drunkenness were tried as prohibitive measures first in the reign of James I. (4 Jac. I., c. 5). The laws being made perpetual in the same reign in "An act to restrain the inordinate haunting of inns and other victualing houses and the propensities to drunkenness" (21 Jac. c. 7) affording evidence of the beginning of the puritanical spirit which characterized that and the subsequent period. The justices were by this act empowered to convict of drunkenness on the testimony of one witness, within six months after the offense committed, and to impose for the first offense a fine of 5s. or the stocks for six hours; for the second offense to bind over the offender in £10 or send him to jail (4 Jac., 5). The licensing justices had to "take bond with good surety for good rule to be kept in alehouses" (5 Ed. VI., 25). Tippling was vigorously put down by four distinct acts of Parliament in James I.'s reign. James was a good example of the distinction between preaching and practicing. Mayeme tells us that his death was expedited by his fondness for sweet wines. The innkeeper suffering tippling was fined ten shillings and had his license suspended for three years (1 Jac. 9), (4 Jac. 5), (7 Jac. 10), (21 Jac. 7), and unlicensed alehouse keepers were fined twenty shillings, and, failing payment within six days, were ordered to be openly whipped (3 Car. I., c. 3). Any person found tippling was liable to a fine of 3s. 4d., or in default "sit in the stocks for four hours." (4 Jac. 5; 21 Jac. 7).

Even wines were under supervision so strict that: "Any under a baron's sonne, or under a 100 marks a yeare, or 1,000 marks in goods; keeping to spend in his house any vessels of Gascoigne wines, French or Rochelle wine above ten gallons loseth £10" (7 Ed. VI., 5).

Many records exist showing the effect of these laws and the fines recorded by churchwardens for the benefit of the poor. Thus the Windsor churchwardens made the following entry in 1618:

"Received more to the use of the poore for drunkenness and absence from church, 11s. 6d." "Item of strangers for drunkenness, 5s." "Vidua Bebe, for tipling in service time, 2s."

Other prohibitive measures of this time can be found recorded in the Salehurst (Sussex) Parish Register for October, 1610. It mentions that, "Henry Turner a prophane drunkard died excommunicate and was buried in the highe way to the terror of drunkards." A still more prohibitive measure of indignity even to the corpse of the habitual drunkard was sanctioned by the reformed clergy of the time, and a record is kept in the Parish Register of Iken (Suffolk), saying that, "On November 10th, 1669, Edward Reeve, lately of Iken Hall returning from Saxmundham 'impletus fortioribus liquoribus' (full of strong liquors) fell from his horse and was killed. The next day towards evening time his body was placed upon a fire and burned."

How shall we deal with those whom, "This abuse of the world, this practicer of arts inhibited and out of warrant," had infolded in its toils and wounded with its cruel fangs? There is but one way, and I will mention it in the language of our President, Dr. Kerr, which surely should create the desired new public opinion.

"Deal with the inebriate," he says, "as you have successfully dealt with the maniac. Frown not on him as a hardened criminal. Remember he has fallen by the power of a physical agency which has crushed to earth some of the noblest and most gifted. Treat him as a patient, laboring under a baffling and inveterate disease, and amid many discouragements, such a measure of success will follow your true curative treatment as will gladden your hearts as men, while it will attest your skill as physicians."

[Continued from SUPPLEMENT, No. 1191, page 19097.]

OPENING ADDRESS BEFORE THE BRITISH ASSOCIATION BY PROF. W. F. R. WELDON, M.A., F.R.S., PRESIDENT OF SECTION D

IN the next case this is not true.

The diagram (Fig. 4) represents the number of female swine, out of a batch of two thousand examined

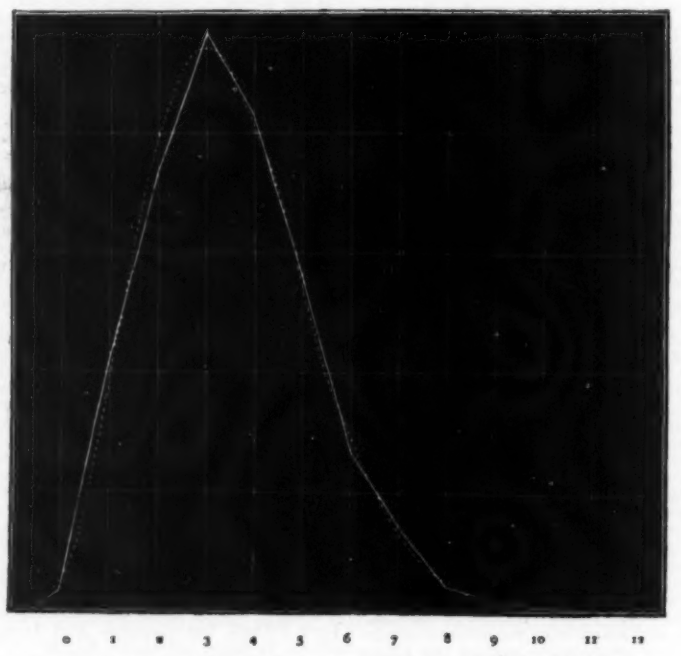


FIG. 4.—DIAGRAM SHOWING THE NUMBER OF MÜLLER'S GLANDS IN EACH OF 2,000 FEMALE SWINE.

in Chicago, which have a given number of Müllerian glands in the right foreleg. The distribution is much more skew than in the case of the crabs, and you see again the very beautiful way in which Prof. Pearson's curve expresses it. You see that the range of variation is much greater on one side of the mean than on the other; and the selective destruction necessary in order to raise the mean number of glands by one would be very different from the amount of destruction necessary in order to lower the mean by one. Further, the mean number of glands in these pigs is 3½; the number which occurs oftenest, the "modal" number, as Prof. Pearson calls it,* is three. Now, it is impossible to lower this number till it is less than 0, so that it can only be diminished by three; but it is conceivable that it should be increased by more than three. So that the amount of selective destruction required in order to change either the mean or the modal character of these pigs in one direction would be greater than the amount required in order to produce a change of equal magnitude in the opposite direction, and the amount of possible change is greater in one direction than in the other.

Now let us pass on to another example.

Table III. shows the variation in the number of petals in a race of buttercups studied by Prof. De Vries. You see that the most frequent number of petals is five, and that no buttercups whatever have less than five petals, though a considerable number have more than five; and here again you see the way in which Prof. Pearson's formula fits the observations.

* See Account of the Instruments of the Bath, by G. Witt, F.R.S., "Archæologia," 47, p. 398.

† Beecher's "Claricles," Scene VI, p. 105, foot-note.

‡ Hallam's "Middle Ages," Chap. ix., part ii.

* All attempts to confine the word "average" to the most frequently occurring magnitude, and the word "mean" to the arithmetic mean of the series, have failed to secure support. Therefore, Prof. Pearson's proposal to call the value which occurs oftenest the "mode" is very useful.

TABLE III.—*Prof. Pearson's expression for the variation in the race of Buttercups described by Prof. de Vries.*

No. of petals	5	6	7	8	9	10	11
Observed frequency	133	55	23	7	2	2	0
Pearson's theory	136·9	48·3	22·6	9·6	3·4	0·8	0·2

You see that if this diagram (which is based on very few specimens) really represents the law of variability in these buttercups, no amount of natural or other selection can produce a race with less than five petals out of them. While it is conceivable that selection might quickly raise the normal number of petals, it could not diminish it, unless the variability of the race should first change.*

These examples, which are typical of others, must suffice to show the way in which the theory of chance, as developed by Prof. Pearson, can express the facts of organic variation.

I think you will agree that they also show the importance of investigating these facts. For of the four characters we have examined, we have seen that two, namely human stature and the antero-lateral carapace length of Carcinus mœnas, vary so as to afford nearly equal material for selective modification in either direction; one character, the number of Müller's glands in swine, offers distinctly greater facility for selective modification in one direction than in the opposite direction; and in the last character the number of petals in a race of buttercups appears to offer scope for modification in one direction only, at least by selection in one generation.

Knowledge of this kind is of fundamental importance to the theory of natural selection. You have seen that the new method given to us by Prof. Pearson affords a means of expressing such knowledge in a simple and intelligible form; and I, at least, feel very strongly that it is the duty of students of animal evolution to use the new and powerful engine which Prof. Pearson has provided, and to accumulate this kind of knowledge in a large number of cases.

I know that there are people who regard the mode of treatment which I have tried to describe as merely a way of saying, with a pompous parade of arithmetic, something one knew before. This criticism of Prof. Pearson's work was actually made to me the other day by an eminent biologist, whose name I will not repeat. If there be any here who hold such an opinion, I would ask them to read Mr. Francis Galton's Essays on Heredity; where a simple and quite unexpected relation between parents and offspring is shown to be a direct consequence of the fact that they vary by chance. This is the first and the most striking deduction from the mathematical theory of organic variation, but it is not the only one. It is enough, however, to show that the new method is not only a simple means of describing the facts of variation, which facts very few people knew before, but it is a powerful instrument of research, which ought to be quickly and generally adopted by those who care for the problems of animal evolution.

I think I have said enough to convince you how entirely Prof. Pearson's method promises to confirm the assertion that organic variation obeys the law of chance.

The other objections to Darwin's theory are not so easily answered. It is said that small variations cannot be supposed to affect an animal's chance of life or death; but few persons have taken any pains to find out in any given case whether the death rate is, in fact, affected by small variations or not. It is said that the process of natural selection is so slow that the age of the earth does not give time for it to operate, but I know of few cases in which any attempt has been made to find out by actual observation how fast a species is really changing.

I can only attempt to discuss the importance of small variations and the rate of organic change in the one case which I happen to know. The particular case I have myself studied is the variation in the frontal breadth of Carcinus mœnas.†

During the last six years my friend Mr. Herbert Thompson and I have studied in some detail the state of this character in the small shore crabs which swarm on the beach below the laboratory of the Marine Biological Association at Plymouth.

I will show you that in those crabs small changes in the size of the frontal breadth do, under certain circumstances, affect the death rate, and that the mean frontal breadth among this race of crabs is, in fact, changing at a rate sufficiently rapid for all the requirements of a theory of evolution.

In Table IV. you see three determinations of the mean frontal breadth of these crabs, expressed in terms of the carapace length taken as 1,000. You see that the mean breadth varies very rapidly with the length of the crab, so that it was necessary to determine it separately in small groups of crabs, such that the length of no two crabs in a group differed by more than a fifth of a millimeter. The first column of the table shows you the mean frontal breadth of twenty-five such groups, between ten and fifteen millimeters long, collected in 1893. These crabs were measured by Mr. Thompson. The second column shows you the mean frontal breadth in twenty-five similar groups of crabs, collected in 1895, and also measured by Mr. Thompson. You see that in every case the mean breadth in a group of crabs collected in 1895 is less than it was in crabs of the same size collected in 1893. The third column contains the result, so far as it is yet obtained, of my own measurement of crabs collected this year. It is very incomplete, because the 1895 crabs were collected in August and September, and I was anxious to compare them with crabs collected this year at the same season, so that there has not yet been time to measure the whole series. The measurements are sufficient, however, to show that the same kind of change has taken place during the last three years as that observed by Mr. Thompson in the interval between 1893 and 1895. Making every allowance for the smallness of the num-

TABLE IV.—*The Mean Frontal Breadth ratio of Male* Carcinus mœnas *from a particular patch of beach in Plymouth, in the years* 1893, 1895, *and* 1898.

Length of carapace.	Mean frontal breadth in terms of carapace length = 1000. 1893 (Thompson).	1895 (Thompson).	1898 (Weldon).	No. of crabs in the 1898 group.
10·1	816·17	809·08	—	—
10·3	812·06	804·82	—	—
10·5	807·37	803·27	—	—
10·7	808·96	801·69	—	—
10·9	805·07	799·27	—	—
11·1	802·50	794·12	784·25	4
11·3	798·18	792·38	787·36	11
11·5	797·19	788·83	784·00	9
11·7	794·28	785·29	782·44	16
11·9	791·45	786·53	780·09	11
12·1	788·38	780·61	775·25	16
12·3	783·98	779·50	773·42	12
12·5	783·99	776·50	767·00	11
12·7	783·58	773·43	772·43	14
12·9	777·38	773·63	764·67	15
13·1	776·63	771·61	760·13	16
13·3	774·60	766·21	761·29	7
13·5	766·91	763·96	759·56	16
13·7	767·63	762·00	757·00	16
13·9	763·73	759·40	756·10	10
14·1	758·94	757·00	742·00	13
14·3	756·90	755·77	747·86	7
14·5	762·60	754·45	744·44	9
14·7	753·00	749·84	739·22	8
14·9	751·32	748·03	742·83	6

bers so far measured this year, there is no doubt whatever that the mean frontal breadth of crabs from this piece of shore is considerably less now than it was in 1895 among crabs of the same size.*

These results all relate to male crabs. The change in female crabs during this time has been less than the change in male crabs, but it is, so far as my measurements at present permit me to speak, going on in the same direction as the change in male crabs.

I think there can be no doubt, therefore, that the frontal breadth of these crabs is diminishing year by year at a rate which is very rapid, compared with the rate at which animal evolution is commonly supposed to progress.

I will ask your patience for a little while longer, that I may tell you why I feel confident that this change is due to a selective destruction caused by certain rapidly changing conditions of Plymouth Sound.

If you look at the chart, you will see that Plymouth Sound is largely blocked up, and its communication with the sea is narrowed by a huge artificial breakwater, about a mile long, so that the tidal currents enter it and leave it only by two openings. This huge modern barrier has largely changed the physical conditions of the Sound.

On either side of Plymouth itself a considerable estuary opens into the Sound, and each of these estuaries brings down water from the high granite moorlands, where there are rich deposits of china clay. Those of you who know Dartmoor will remember that in rainy weather a great deal of china clay is washed into the brooks and rivers, so that the water frequently looks white and opaque, like milk. Much of this finely divided china clay is carried down to the sea; and one effect of the breakwater has been to increase the quantity of this fine silt which settles in the Sound itself, instead of being swept out by the scour of the tide and the waves of severe storms.

So that the quantity of fine mud on the shores and on the bottom of the Sound is greater than it used to be, and is constantly increasing.

But this is not all. During the forty or fifty years which have gone by since the breakwater was completed, the towns on the shores have largely increased their population; the great dockyard at Devonport has increased in size and in activity; and the ships which visit the Sound are larger and more numerous than they were. Now the sewage and other refuse from these great and growing towns and dockyards, and from all these ships, is thrown into the Sound; so that while it is more difficult than it used to be for fine silt to be washed out of the Sound, the quantity thrown into it is much greater than it was, and is becoming greater every day.

It is well known that these changes in the physical conditions of the Sound have been accompanied by the disappearance of animals which used to live in it, but which are now found only outside the area affected by the breakwater.

These considerations induced me to try the experiment of keeping crabs in water containing fine mud in suspension, in order to see whether a selective destruction occurred under these circumstances or not. For this purpose, crabs were collected and placed in a large vessel of sea water, in which a considerable quantity of very fine china clay was suspended. The clay was prevented from settling by a slowly moving automatic agitator; and the crabs were kept in under these conditions for various periods of time. At the end of each experiment the dead were separated from the living, and both were measured.

In every case in which this experiment was performed with china clay as fine as that brought down by the rivers, or nearly so, the crabs which died were, on the whole, distinctly broader than the crabs which lived through the experiment, so that a crab's chance of survival could be measured by its frontal breadth.

When the experiment was performed with coarser clay than this, the death rate was smaller, and was not selective.

I will rapidly show you the results of one or two experiments. The diagram (Fig. 5) shows the distribution of frontal breadths, about the average proper to their length, in 248 male crabs treated in one experiment. Of these crabs, 154 died during the experiment and 94 survived. The distribution of frontal breadths in the survivors is shown by the lower curve in the diagram, and you see that the mean of the survivors is clearly below the mean of the original series, the mean of the dead being above the original mean.

Two other cases, which are only examples of a series in my possession, show precisely the same thing.*

These experiments seemed to me to show that very finely divided china clay does kill crabs in such a way that those in which the frontal breadth is greatest die first, those in which it is less live longer. The destruction is selective, and tends to lower the mean frontal breadth of the crabs subjected to its action. It seemed to me that the finer the particles used in the experiments, that is to say, the more nearly they approached the fineness of the actual silt on the beach, the more selective their action was.

I therefore went down to the beach, where the crabs live, and looked at the silt there. This beach is made of moderately small pieces of mountain limestone, which are angular and little worn by water. The pieces of limestone are covered at low tide with a thin layer of very fine mud, which is much finer than the china clay I had used in my experiments, and remains suspended in still water for some time. Under these stones the crabs live, and the least disturbance of these stones raises a cloud of very fine mud in the pools of water under them. By washing the stones of the beach in a bucket of sea water, I collected a quantity of this very fine mud and used it in a fresh series

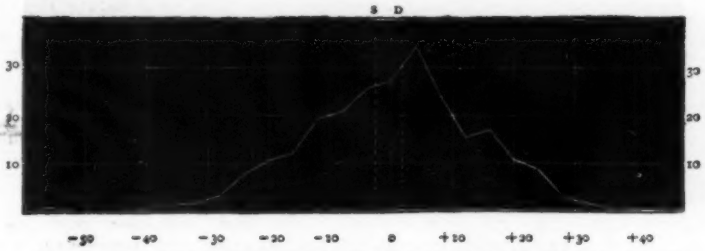


FIG. 5.—DIAGRAM SHOWING THE EFFECT OF CHINA CLAY UPON 248 MALE CRABS.

The upper curve shows the distribution of frontal breadths in all these crabs; the dotted curve the distribution of frontal breadths in the survivors. The dotted line, *S*, shows the mean of the survivors; the line *D* the mean of the dead.

of experiments, precisely as I had before used china clay, and I obtained the same result. The mean frontal breadth of the survivors was always smaller than the mean frontal breadth of the dead.

I think, therefore, that Mr. Thompson's work, and my own, have demonstrated two facts about these crabs; the first is that their mean frontal breadth is diminishing year by year at a measurable rate, which is more rapid in males than in females; the second is that this diminution in the frontal breadth occurs in the presence of a material, namely, fine mud, which is increasing in amount and which can be shown experimentally to destroy broad-fronted crabs at a greater rate than crabs with narrower frontal margins.

I see no shadow of reason for refusing to believe that the action of mud upon the beach is the same as that in an experimental aquarium; and if we believe this, I see no escape from the conclusion that we have here a case of natural selection acting with great rapidity because of the rapidity with which the conditions of life are changing.

Now, if we suppose that mud on the beach has the same effect upon the crabs as mud in an aquarium has, we must suppose that every time this mud is stirred up by the water a selective destruction of crabs occurs, the broad-fronted crabs being killed in greater proportion than the narrow-fronted crabs.

Therefore, if we could take a number of young crabs and protect them through a certain period of their growth from the action of this selective mud, the broad-fronted crabs ought to have as good a chance of life as the rest; and in consequence the protected crabs should contain a larger percentage of broad individuals than wild crabs of the same age; and the mean frontal breadth of such a protected population ought to be greater, after a little time, than the mean frontal breadth of wild crabs, in which the broad individuals are being constantly destroyed.

It is difficult to perform this experiment, because one cannot know the age of a crab caught on the shore. But so far as one can judge the age of a crab by its length, I can show you that the thing which ought to happen, on the hypothesis that such selective destruction is going on, does actually happen.

I established an apparatus consisting of some hundreds of numbered glass bottles, each bottle being provided with a constant supply of clean sea water by

* Of course, we know that selection does change the variability of a race.

† In 1894 I gave an account of the variation of this dimension in female specimens of various sizes (Roy. Soc. Proc., vol lvii.), and I put forward an hypothesis of the amount of selective destruction due to variation in this character. That hypothesis neglected several important facts which I now know, and was open to other objections. I desire to replace it by the results of the observations here recorded.

* I shall, of course, consider it my duty to justify this statement by more extensive measurement as soon as possible. In the meantime I may say that I have measured other small groups of crabs, male and female, from the same place at different seasons of the years 1896-98, and the results agree with those recorded in the table.

* It is impossible in this place to give a full account of the experiments referred to, and a multiplication of mere small scale diagrams seems useless, so that only one of those exhibited when the address was delivered is here reproduced.

means of a system of glass siphons. Into each of these bottles I placed a crab from the beach. After a considerable number of deaths had occurred, a series of crabs was finally established, each crab living in a numbered bottle, until it had cast its shell. The process of moulting involves no distortion of the carapace which could affect the measurements concerned, and therefore each cast shell was carefully measured. The measurements of these shells were carefully compared with measurements of wild crabs of the same size, and the mean frontal breadth of these shells was a little less than the mean breadth in wild crabs of corresponding length.*

After each crab had moulted it was left in its bottle until it had grown and had hardened a new shell. It was then killed and measured, and the measurements obtained were compared with measurements of wild crabs of corresponding size. This time the captive crabs were unmistakably broader than wild crabs of their own size, and there were a few of the protected crabs which were very remarkably broad. The distribution of abnormalities before and after moulting is shown in Fig. 6.

This is precisely the result which we ought to have obtained, if the hypothesis suggested by the study of mud were true. By protecting crabs through a period of their growth we ought to raise the mean frontal breadth and to obtain a greater percentage of abnormally broad crabs, and that is what we have seen to occur.

Of course, this experiment by itself is open to many objections. The estimate of age by size is a dangerous proceeding, and it is difficult to exclude the possibility that confinement in a bottle may directly modify a crab during the critical period of moulting, and so on. All these points would have to be discussed at greater length than your patience would bear before we could accept this experiment by itself as a proof that some selective agent exists on the shore which is absent from the bottles. At the same time, the result of this experiment is exactly what we should expect to find if such a selective agent did exist, and so it is in complete harmony with the evidence already put before you.

Of course, if the observed change in frontal breadths is really the result of selection, we ought to try to show the process by which this selection is effected.

This process seems to be largely associated with the way in which crabs filter the water entering their gill chambers. The gills of a crab which has died during an experiment with china clay are covered with fine white mud, which is not found in the gills of the survivors. In at least 90 per cent. of the cases this difference is very striking; and the same difference is found between the dead and the survivors in experiments with mud.

I think it can be shown that a narrow frontal breadth renders one part of the process of filtration of water more efficient than it is in crabs of greater frontal breadth.

It would take too long to go into that matter now, and I shall not attempt to do so. I will only now ask you to consider one or two conclusions which seem to me to follow from what I have said.

I hope I have convinced you that the law of chance enables one to express easily and simply the frequency of variations among animals; and I hope I have convinced you that the action of natural selection upon such fortuitous variations can be experimentally measured, at least in the only case in which any one has attempted to measure it. I hope I have convinced you that the process of evolution is sometimes so rapid that it can be observed in the space of a very few years.

I would urge upon you in conclusion the necessity of extending as widely as possible this kind of numerical study. The whole difficulty of the theory of natural selection is a quantitative difficulty. It is the difficulty of believing that in any given case a small deviation from the mean character will be sufficiently useful or sufficiently harmful to matter. That is a difficulty which can only be got rid of by determining in a number of cases how much a given variation does matter; and I hope I have shown you that such determination is possible, and if it be possible, it is our duty to make it.

We ought to know numerically, in a large number of cases, how much variation is occurring now in animals; we ought to know numerically how much effect that variation has upon the death rate; and we ought to know numerically how much of such variation is inherited from generation to generation. The labors of Mr. Galton and of Prof. Pearson have given us the means of obtaining this knowledge; and I would urge upon you the necessity of obtaining it. For numerical knowledge of this kind is the only ultimate test of the theory of natural selection, or of any other theory of any natural process whatever.

* This was probably due to the death rate during acclimatization being selective. It was very difficult to keep the apparatus clean; and the deaths which occurred were, in most cases, due to the presence of putrescent bits of food, which had not been removed.

A subsequent experiment was made with the same apparatus, in which crabs were kept in putrid water until a large percentage had died; and the mean frontal breadth of the survivors was found to be distinctly less than the mean frontal breadth of the dead.

FIG. 6.—DISTRIBUTION OF ABNORMALITY OF FRONTAL BREADTH RATIOS IN 527 FEMALE CRABS BEFORE AND AFTER MOULTING IN CAPTIVITY.

The continuous line shows the distribution before, the dotted line after moulting.

COMPARATIVE AMERICAN CIVILIZATION.

By HUBERT HOWE BANCROFT.

To arrive at an approximate idea of the social condition of the several tribes inhabiting America at the time of its discovery by Columbus, we have simply to compare these tribal characteristics one with another and with European and Asiatic civilization.

As to the question of races or species in America, ethnologists seem well enough agreed to call the American Indians all one people, however diversified in culture, traits, and languages—all save the Eskimos, who circle around the north pole, and belong as much to one continent as to another. That is to say, however American tribes and nations may differ from each other, they differ yet more from all the rest of the world, and have many of their own peculiar resemblances in common. Nor does it seem profitable to spend further time in attempting to prove what can never be known until every Whence and Whither are made clear to man—the origin of the American Indian.

The first question the Spaniards asked themselves on landing was: By what route came these people hither from the general Babylonian break-up? And the next: Have they souls? The latter was the more important, and must of necessity be decided in the affirmative, else the church were without occupation in this vast domain, and the pretty native girls obviously could not serve as mistresses to the pious cavaliers. Thus, the question of soul was decided, and, if anyone can tell what soul is, we have that as a starting point; in this respect the Americans are placed in the same category as the Europeans. Next, as to intellect. It would be difficult to prove that the native American intellect was inferior to that of the European or Asiatic; that there were not scattered throughout the wilderness here and there a Plato, a Shakespeare or a Christ. Among the Mexicans and Peruvians were poets, philosophers, and statesmen of no mean order. Within the present century we have one example, at least, of a pure-blooded Aztec boy, who could not even speak the Spanish language, when at the age of twelve years, to escape punishment by an uncle for neglect of task imposed, he followed a cattle-drover from the mountains into the city of Oajaca, where a Catholic priest took him up to educate for the church; the young man emancipating first himself, and then all Mexico from intellectual thraldom. As true greatness may be measured—nobleness of heart united with mental and moral supremacy—there never lived a greater or a better man, or one who accomplished more grand and wonderful things, and from the purest and most unselfish of motives, than this full-blooded American Indian, Benito Juarez.

His achievements were more intricate and more important than those of any Washington or Bolivar, of any Napoleon or Alexander. While yet his mind was being trained to accept the dogmas and obey the mandates of the church, he saw in that church an overwhelming religious despotism, holding in its hands three-fourths of all the property in the country, swaying politics and society, mind and morals, the material and intellectual, at will. He saw the nation broken into scores of petty revolutions, and the roads infested with banditti. Then came the Frenchmen with their Austrian prince, thinking to plant imperialism in America while the United States were engaged in deadly strife for the preservation of their own integrity. As lawyer, judge, state governor, and finally as president of the republic, Juarez emancipated Mexico from the power of the church, put down to a great extent revolution, and centralized the strength of the republic, and finally drove out the foreign invaders, thus leaving the country at his death all well prepared for the prosperous and benignant regime under Porfirio Diaz.

Hundreds of examples could be cited, as Pontiac, Red Jacket, Techotlalatzin, and Manco Capac, showing the brain power of American aborigines. As to physique, the difference, if any, is not worth discussing. So with morality and religion; those of the old world were as bad as they could be, therefore those of the new world could be no worse. The Americans sacrificed human beings to their gods of wood and stone; the Europeans sacrificed human beings to their lust and avarice. For every heart torn from an innocent breast and thrown to Huitzilopochtli, a hundred innocent human beings were butchered in the name of Christ. Little to choose between them on the score of humanity and superstition!

Hence we may say that as between Americans and Europeans, in body, soul, intellect, morality, and religion, there was practically no difference.

For the state of culture in America as compared with culture in Europe we must look therefore alone to science, art, and literature; to the inventions, contrivances and paraphernalia of civilization; and there was less difference in all these than may be supposed. I am speaking of the more advanced nations of America, of course, of the Iroquois, or nobler type of the American Indian proper; of the Nahuas and Mayas of Mexico and Central America, and the Peruvians of South America, and not of the lower orders of humanity occupying the arid inland regions of North America or the malarious seaboards of the tropics or the wind-whipped regions of the southern horn.

The civilized nations of America had their systems of ethics, of jurisprudence, of government, as well as their literature, arts, science, commerce, and manufactures; but, as a rule, they were all inferior to those of Europe. The first great drawback with the Americans was their ignorance of the use of iron; next gunpowder and printing, which last two indeed had then not been long in use in Europe. Iron is a great civilizer; it was nowhere used in North or South America. Copper was known, and the gold and feather work of the Americans was superior to anything of the kind in Europe. In the way of domestic animals the Americans were lamentably deficient, women being their beasts of burden. The Peruvians had their llama, and in some parts there were bisons and other tamed beasts; but as a rule it may be said that the Americans had neither iron nor domestic animals, and that herein lay the cause of the chief differences between the civilizations of Europe and America.—The American Antiquarian.

THE ADVANCE OF PSYCHOLOGY.*

THE American Association for the Advancement of Science, when it first met fifty years ago, had no place for anthropology nor for psychology. Science has its origin in the practical needs of society. In a new country of great area and rich resources the energies of its people were directed to invention and exploration. The spirit of Franklin led to the development of railways, steamboats, and telegraphy, to the building of cities and the search for mines.

But not only in America and in the case of the anthropological sciences have fifty years brought great changes. Science has become a leading factor in modern life by the rapidity rather than by the duration of its growth. Our own revered Dr. Hall might have talked with Herschel, who could almost have touched the hand of Newton. Newton was born the year that Galileo died. If Copernicus had lived to extreme old age, he might have handed the De Orbium Celestium Revolutionibus to Galileo. While the whole history of science is thus nearly spanned by five lives, modern science is scarcely older than our association. It was only in the decade of its foundation that the doctrine of the conservation of energy was announced, while the Origin of Species was published in the year of our eleventh meeting. If the physical sciences, as we now understand them, are scarcely more than fifty years old, and the biological sciences are only forty years old, the anthropological sciences are still younger. Perhaps these are now in the condition of the physical sciences before they had become truly exact, of the biological sciences before they had become truly genetic.

It is easy to prophesy after the event, and from our present point of view science in its history appears to have followed a necessary course. The phenomena of the physical world are stable and readily subject to experiment and measurement; their control is essential to material progress. It is, therefore, no wonder that the physical sciences should have preceded the biological sciences in their development. Far more complex, transient, and inaccessible to experiment even than the phenomena of living beings are men, they themselves and their deeds—sciences of these things must come late. As man has been evolved from simpler forms of life, and these were preceded by a lifeless earth, so the sciences dealing with man, with life, and with matter must be based one upon the other. The history of science is, therefore, full of promise for the student of anthropological science. We may grant the past to others and claim the twentieth century for our heritage. Perhaps our Copernicus, our Newton, our Lavoisier, our Darwin, is one of the younger members of this section.

It may, however, be that the subject matter of the anthropological sciences is such that they will proceed without catastrophe. The form of the earth is altered by earthquakes on occasion, but every day it is moulded to a greater degree by less obtrusive agencies. In the making of the anthropological sciences by the collecting and arranging of facts, by discovery and by generalization, we have every reason to be satisfied with the part taken by America and by this Association. In many sciences we must at once yield the leadership to older nations. In the youngest of the sciences we at least stand on terms of equal service. It was perhaps by special providence that last year's meeting of our Association was presided over by an anthropologist, but this year we chose to celebrate our fiftieth anniversary under a member of this section. That this section should have supplied three of our last five presiding officers and our permanent secretary for twenty-five years; that the British Association should have come to America to establish its section of anthropology and on its second visit should have chosen an anthropologist for its president—these things we may at least regard as an omen of the place of anthropology in the science that is to be and of the place of America in anthropology.

While anthropology, largely owing to the richness of the material at hand and to the great Bureau of American Ethnology established to investigate this material, has come to such fruition in America, psychology has also shown great vitality. Unlike anthropology, psychology is distinctly a university discipline. For reasons chiefly theological, ethical, and educational, mental and moral philosophy had been taught from the foundation of our colleges by the president of each institution to all students. It happened that at the same time that psychology had developed into a science, the college president became an executive officer, no longer chosen as a matter of course from the clergy, having neither time nor training for the teaching of mental science. There was thus an empty place which the modern psychologist was prepared to fill. Further, the rapid development of the college into the university with elective courses permitted psychology to compete on equal terms with the older sciences, and the result has been its secure establishment in the university. Indeed, psychology, touching with one hand philosophy, the humanities, and the historical and political sciences, while with the other hand it reaches toward the natural and ex-

* Address by J. McKeen Cattell, Vice-President of Section H—Anthropology—of the American Association for Advancement of Science, August, 1898.

act sciences, bids fair to become central. Thus, at Harvard, Prof. Münsterberg's elective course in empirical psychology was this year followed by 365 students. At Yale Dr. Scripture's course in physiological and experimental psychology was elected by 138 students. There were last year given by American universities 18 doctorates with psychology as the major subject—more than in any science except chemistry, six times as many as in astronomy, and nine times as many as in anthropology.

Psychology, though its recent development has been so rapid, is not a new science; it should rather be regarded as one of the oldest of the sciences. Under the great dynasty of philosophers—founded in Greece, not extinct even during the Dark Ages, re-established after the Renaissance—all the sciences were developed. From Aristotle to Kant the history of philosophy is in large measure the history of science. But as the domain of knowledge became too great to be ruled by a single mind, it must needs be divided into the principalities that we call the sciences. From the beginning psychology has been the favored nursling of philosophy, and, as the other sciences were taken from it, all the more did it cherish that which was left. In Great Britain Locke, Berkeley, and Hume and their English and Scottish successors to the present time have been at once students of philosophy and of psychology. The same may be said of Herbart, Lotze, Wundt, and many more in Germany and in France. In our own country to-day we find many of our leaders—James, Ladd, Royce, Dewey, Fullerton, and others—professing equally philosophy and psychology.

Psychology, under the guidance of philosophy, became at times somewhat schematic and unreal, though never I think unfruitful or regressive. It needed, however, to be cross fertilized with the natural sciences. These sciences, in their development, could not ignore the senses and the mind. Perceptions are parts of a physical system, but they are also parts of an individual consciousness. Newton not only analyzed light, but also named seven colors; Dalton found that he was blind to certain of them; Young invented a theory to account for their combinations; Von Helmholtz reviewed the phenomena in one of the greatest of books. Physiology on its side could not study the senses and brain while ignoring the functions that they subserve, and it was found that the methods of natural science could be applied in psychology. The zoologist could not neglect the mental life of animals and the place of consciousness in evolution. Darwin wrote not only The Origin of Species, but also The Descent of Man, and The Expression of the Emotions, and was the first to study the development of the child's mind.

The subject matter having been supplied by philosophy and the methods by natural science, the way was made ready for the establishment of a science of psychology. This we owe largely to the intellectual patience of Germany, tired at last of the Hegelian metaphysics. Lotze published his Medicenische Psychologie in 1852; Fechner his Elemente der Psychophysik in 1860; Wundt his Menschen und Thierseele in 1863, and his Physiologische Psychologie in 1874. Lotze and Wundt were doctors of medicine; Fechner was a professor of physics; they were all deeply interested in philosophy. Psychology, as pursued to-day, is deeply indebted to these three, perhaps chiefly to Wundt, who, continuing his services, founded in 1879 the first laboratory of psychology, and established in 1883 a journal for the publication of its investigations. Following and leading this psychological movement we find in Germany men such as Stumpf, Lipps, Ziehen, Müller, Ebbinghaus, and many more. One of them—Münsterberg—has come to us, while Höffding, of Denmark, may be included in the same group. Physiologists, such as Hering, Aubert, Preyer, Flechsig, Exner, and Von Kries, and physicists, such as Von Helmholtz, Mach, and König, may reasonably be claimed, in part at least, for psychology.

In France a philosopher, as Cousin, or a man of letters, as Taine, may have accomplished somewhat, but modern writers and workers, as Ribot and Binet, have been largely influenced by Germany. France has, however, made two independent contributions of importance, though in both cases chaff has been mixed with the grain. These are, on the one hand, abnormal and pathological psychology and, on the other hand, individual and social psychology.

In Italy the names of Lombroso and Mosso remind us of work in criminology and in physiology that has become important for psychology, as is also the case with the histological work of the Spaniard, Ramon y Cajal. In Russia performance waits on promise.

Great Britain has developed a modern psychology without breaking with its traditions. It has always been a land of great individuals, and Locke, Berkeley, and Hume have found worthy successors in Bain, Ward, and Stout, to mention only three living psychologists belonging to three different generations. Darwin, Huxley, and Spencer, while establishing the theory of evolution, gave mind its due place, Spencer having concerned himself especially with mental and social evolution. Romanes and Lloyd Morgan have directed attention to the study of animal intelligence, while Galton's contributions to anthropometry and heredity have exhibited great originality. Experimental psychology has not made much headway in Great Britain. They have let us take from them Titchener; so he must count for America. The first laboratory, at Cambridge, was founded by me and maintains a humble existence. Within a year a laboratory has been founded at University College, London, and Oxford has at least awakened to the existence of experimental psychology, to the extent of decreeing this summer that it shall not be taught under a newly established lectureship of mental philosophy.

This American Association is naturally most concerned with what has been accomplished for psychology in America. The history of psychology here prior to 1880 could be set forth as briefly as the alleged chapter on snakes in a natural history of Iceland—"There are no snakes in Iceland." The eminence of the theologian Jonathan Edwards is witness to the lack of any psychologist. We had only text books by college presidents setting forth Scottish realism. Porter, of Yale, gave us the best of these books, but McCosh, of Princeton, performed a greater service by placing the ægis of theological conservatism over both organic evolution and experimental psychology.

But the land lay fallow, and twenty years ago the seed was sown. James, at Harvard, began the publication of a series of striking articles, culminating in the issue, in 1890, of The Principles of Psychology, a work of genius such as is rare in any science or in any country. Hall, in 1883, established in the Johns Hopkins University the first American laboratory of psychology—the second in the world*—since transferred to Clark University. The American Journal of Psychology, founded by him in 1887, shows the value of the work accomplished at Johns Hopkins and Clark, while the Pedagogical Seminar bears witness to his influence in stimulating interest in the child's development. Ladd published, in 1887, his Elements of Physiological Psychology, a work that has exerted great influence both here and abroad. It has been followed by a series of treatises on psychology that have never been equaled in range and thoroughness.

Under James, Hall and Ladd and in Germany there was then trained a second generation of psychologists, and we ourselves now have our students, a third generation. The second American laboratory was under my direction at the University of Pennsylvania. The first chair in psychology was there established and courses in laboratory work were there first given. This was only ten years ago. The work at Pennsylvania is continued under Witmer, while at Columbia we have, since 1890, a laboratory and a range of courses in experimental, physiological, and analytic psychology which may bear comparison with those of the other sciences. Baldwin carried modern psychology, himself enlarging it as he went, from Princeton to Lake Forest and thence to Toronto and back to Princeton. The laboratory established by him at Toronto is continued under Kirschmann, while at Princeton he has founded an efficient laboratory, and by his work on genetic psychology has brought our science into fruitful relations with zoology and sociology. Jastrow, at Wisconsin, stands forward as a leader in experimental psychology, having accomplished much for the advancement of the science and the diffusion of its results. In the latter connection may be mentioned the psychological laboratory under his direction at the Columbian Exposition and the fact that almost alone he has represented psychology in this Association.

The great services for psychology of James at Harvard, Hall at Clark, and Ladd at Yale, were not confined to their own publications, but were also directed toward building up strong departments. Harvard, with James, Münsterberg, Royce, Santayana, MacDougal and other men in closely related departments, surpasses every other university in the world in its opportunity for psychological study and researches, and there is quite as much reason for German students to come to Harvard as for our students to go to Germany. Clark University, where Sanford has charge of the laboratory, may almost be said to be a university for the advancement of psychology. The laboratory at Yale, under Scripture, has shown great activity and is able to publish annually a volume of researches. Cornell, under a president who is a student of philosophy and psychology, robbed Great Britain of its best experimental psychologist, and under Titchener the laboratory stands quite to the front, while the courses in philosophy and psychology are especially well developed. Chicago early recognized the importance of psychology. Securing Dewey and Mead from Michigan and Angell for experimental work from Minnesota, in psychology, as in other departments, its development has been marvelous. Michigan and Minnesota have found other men to continue the work, while Stanford, California, Indiana, Iowa, Illinois and all the great State universities have established laboratories and given an adequate place to psychological courses.

It would be possible for me to give other objective proofs of the progress of psychology—the establishment, in 1894, of a second journal, The Psychological Review, which during the first six months of the present year has published some 900 pages, all, we hope, contributing to the advancement of psychology; the prominent place given to psychology in our journals of education, philosophy, general science and popular literature; the widespread amateur interest in child-study and psychical research; our Psychological Association, with a membership of 102, all engaged in advancing psychology—these and other witnesses for psychology might be called upon to testify, but the development of psychology in the university has seemed to me best deserving of extended comment. Until the State shall learn to care for those who do the most for it, until those who are engaged in advancing knowledge shall work for the State and be supported by the State, our universities will be the centers for research, and the position of a science in the university will measure its opportunity and fruitfulness. Very significant for psychology, therefore, is its progress in the universities of America during the past twenty years.

My remarks have been confined to the externals of psychology. Its inner history, its present content, its future outlook, are not subjects that can be readily brought up and dismissed in a few words. Psychology is the most complex of the sciences. I do not at all claim that it is the most important of the sciences. The human race got on without it very well and could doubtless continue to do so. Its practical applications do not compare in importance with those of many of the sciences; it is in a way lacking in great discoveries and universal laws. But, compared with psychology, a science such as astronomy may almost be regarded as naive. The entire known performance of the solar system and of the fixed stars since the time of the Chaldæans is less complicated than the play of a child in its nursery for a single day. The stars are so far away, the telescopes are so big, eclipse expeditions proceed to such remote quarters of the earth, that the simplest items of information take on a dramatic interest. Atoms and molecules are so invisible, the ether is so intangible, we know after all so little about them, that it is easy to invent hypotheses that do not contradict our ignorance. The generalizations of physical science are, indeed, the greatest achievements of the human intellect, but the intellect, by which and for which these generalizations have been created, when itself made the subject-matter of a science, is complex beyond those sciences which are its offspring.

Psychology does not, of course, claim as its subject-matter all "that is in heaven above, or that is in the earth beneath, or that is in the waters beneath the earth." The physical and natural sciences, language, literature and the fine arts, industries, and institutions have, it is true, their origin and end in the mind, but this does not turn them into departments of psychology. The physicist no more needs to concern himself with the mental processes leading to his discovery than does the hen with the processes preceding the laying of its egg. The kind of novel called psychological is by no means a product of science. The enjoyment of art decreases as we analyze its products. Scientific prevision and guidance have scarcely more to do with the rise and decline of institutions than with the rise and decline of the sun in the firmament.

Still I do claim that there is no department of knowledge or activity which does not have an aspect that concerns psychology, and while hitherto it is psychology which has learned from sciences preceding it in their development, the time will come, and perhaps has now come, when every science must take into account the facts and theories of psychology. The increase of knowledge which has caused the creation of the separate sciences is now leading to further specialization, but not in the sense of one science more completely ignoring the others. Rather we have at present well established sciences, such as astrophysics, physical chemistry, biology and others which take their subject matter from two or more of the older sciences. It is probable that students in increasing numbers will take up the inter-relations of psychology with other sciences. Indeed, this tendency is already well marked. Mathematics is necessary as a tool for psychology, while conversely several books have recently been published concerned with the psychological presuppositions of mathematics. The fundamental concepts of mechanics have been treated as mental products by Mach, Pearson, and others. At the present moment the Vice-President is giving, before the Section of Physics, an address on the perception of light and color, while the same subject was chosen by Sir George Stokes last month for the subject of his address before the Victoria Institute. Physics is, however, leaving to psychology vision, hearing, etc., though in the meantime new departments, destined perhaps to become new sciences—represented by the great works of Von Helmholtz, Physiologische Optik and Tonempfindungen—are being created, which draw their materials in equal measure from physics, from physiology and from psychology. Errors of observation, the personal equation, the relation between mental and physical intensity, are subjects where the investigations of the psychological laboratory must be applied in astronomy and the other physical sciences. Chemistry, geology, and botany perhaps stand most remote from psychology. Still, if physiology is in large measure the chemistry of living tissues, chemistry may be brought into intimate relations with psychology. Geology and anthropology are closely related, while physical geography is especially concerned with the relations of man to the earth. Many of the problems of evolution, so essential for psychology, are best studied in plants, and the applications of botany in agriculture, etc., are determining factors in the evolution of man.

Physiological psychology is already accepted as a distinct discipline, while zoology and psychology are equally intertwined. It is impossible to separate physical and mental evolution—witness the writings of Darwin, Spencer, Huxley, Romanes, Cope, Morgan, and many more. Under the classification of this Association anthropology and psychology are included in one section. Several of our leading members would make psychology a branch of anthropology, while psychology regards ethnology and archæology on the one hand, and somatology, on the other, as contributing much to its subject matter. Sociologists find it somewhat difficult to disentangle their field from that of psychology.

If we turn to the departments of knowledge not represented in this Association—the humanities—we find psychology to be a connecting link between them and the physical and natural sciences. If we regard the professions—medicine, law, theology, teaching, journalism—we find that their products when systematized into sciences give to psychology and take from it. Literature and the fine arts, both in their origin and in their end, may be studied as departments of psychology, though it does not appear that psychology has as yet been of great service to them.

I may illustrate the interdependence of psychology and other sciences by a definite example. Much is being written just now regarding the relation of consciousness to the brain. The question is: Do perceptions, thoughts, feelings, volitions, stand in causal interaction with the brain, or are they an epiphenomenon, accompanying changes in the brain, but not influencing them? Are our ordinary actions complex reflexes due to physical stimuli and the structure of the nervous system, or are the changes in the brain that precede movements initiated and directed by consciousness? The question is one of facts, that should be settled by scientific methods; and the solution will by no means concern psychology alone. The two greatest scientific generalizations of the present century are the conservation of energy and evolution by survival of the fit. Now, if consciousness alters, however slightly, the position of molecules in the brain, the fundamental concept of physical science must be adandoned. If consciousness have no concern in the actions of the individual, we have one of the most complex results of evolution developed apart from the survival of useful variations, and the Darwinian theory has failed. Surely both the physicist and the biologist must watch the steps toward the solution of a problem that concerns them so nearly.

The world is one world; every part of it is in relation to every other part, and each part consists in these relations. As a hand cut off from the rest of the body is no longer a hand, as a man apart from other men is no longer a man, so each science and each scientific fact and law has its value and even its existence in its relation to the totality of knowledge and of life. Psychology has become an integral part of modern science; it gives and takes with a free hand. A parvenu among the sciences, it is self-conscious and knows

* It would be more correct to regard the laboratory established about the year 1875 by James in the Scientific School of Harvard University as the world's first psychological laboratory. It was, however, nominally under physiological auspices.

its obligations and its limitations; but its position in the body scientific is henceforth secure.

I have said that psychology is in a way lacking in great discoveries and universal laws. If I were addressing an audience of psychologists, it might be desirable to consider whether this is due to the subject matter or only to the immaturity of our science. Under present circumstances it is perhaps better in part to question my own statement. Columbus discovered a new world; Copernicus discovered innumerable worlds; but Descartes discovered, or at all events invented, the soul. Which after all was the greater scientific advance? Columbus did not foresee four hundred years of history, the present unequal conflict of a powerful nation with a declining civilization. Descartes' ideas of the relation of mind and body are not ours. But is not the very subject matter of psychology one of the greatest discoveries of modern science? To unite strict idealism with strict materialism; to give consciousness its central place in the universe and yet to show that each change in consciousness is correlated with a change in the nervous system—this I claim to be a scientific generalization comparable to that of the conservation of energy or of organic evolution.

Minor but clear-cut discoveries in psychology have not been lacking—witness color-blindness, individual types of mental imagery, the dependence of emotion on reflex bodily movements, hypnotism, etc. Neither are quantitative formulas denoting relations among mental states or between mental and physical change lacking. Recent researches on subjects such as the perception of space, illusions of sense, color vision, the time of mental processes, memory, fatigue, and many more represent scientific advances as definite, interesting, and important as those of physics or of zoology. Psychology has been able to adopt the quantitative methods of exact science and the genetic methods of natural science, while its older methods of description and analysis witness an insight and acuteness unrivaled by any other science.

I have said that the practical applications of psychology do not compare in importance with those of many of the other sciences. Here again, while a society of psychologists might properly discuss the causes of this limitation, in an address confined to generalities it may be more profitable to point out that daily life consists in the application of such psychological knowledge as is at hand. How could Bismarck and Gladstone direct contemporary history except by superior insight into the way men act and the methods of influencing their actions? What have Wagner and Browning done except excite interest and emotion? The conduct of every profession and of every business is chiefly based on the adjustment of thoughts, feelings, and actions. Systems of government and education are simply methods for controlling and directing the human mind. Now, of course, all this is done by the rule of thumb entirely uninfluenced by psychology as a science. The savage who kills a bird with a stone is not thereby shown to be a zoologist and a physicist. Still he does have a kind of knowledge of the habits of animals and of the laws of projectiles, whence have developed the sciences, which in the course of time have turned back to daily life those applications of science in which modern civilization consists. Whether the history of the material sciences will be repeated in the case of the mental and social sciences it is not possible to say or to gainsay. There are at present indications of the application of psychology in the treatment of diseases, in education, and in other directions. Evolution, careless of the individual, has proceeded with boundless waste; certainly we are now interfering with its course for our benefit. It may be that some day the applications of material science will be subordinate to those of psychology.

These things lie on the knees of the gods. What the future will bring we do not know, but the past is ours. When we regard the fifty years of this association or the century now ending, we cannot fail to see that it has been an era of science. German music, English poetry, the modern novel—these are great achievements, but scarcely comparable to the forward movement in science. The older sciences have been reformed and new departments have been established. But amid all this scientific progress nothing has been more notable—at least from my own partial point of view—than the development of psychology into a science rivaling in activity and fruitfulness the other great sciences.

A miniature garden, 15 by 13 feet, representing a district in Arashi-Yama, west of Saikyo, the ancient capital of Japan, is being laid out upon the lawn of John H. A. Klaudler's residence in Philadelphia. The garden, which is being arranged under the supervision of the Japanese artist, Teitoku Morimoto, is filled with miniature Japanese buildings, which represent a Buddhist temple, with its group of eight structures and its arch, or torii, and its toro lanterns. On the southwest corner of the garden is a representative of a Shinto temple, with its group of buildings, torii, and toros. From the summit of Arashi-Yama is a waterfall and cascade, which is supplied from an inch pipe. The water tumbles down the rocky mountain side, and in one place represents a celebrated falls, known as Shiraeto-no Taki, or white thread, and flows into the Katsura River, in which there are a number of islands, and a representative of what is known as the shifting island. The river itself is a series of rapids.—Philadelphia Record.

At the International Chemical Congress at Vienna, Mr. Chistomanos read two papers on greenokit and cadmium in Greece. Calomine has for years been mined in Attica. It is generally a fairly pure carbonate of zinc, but also colored with other metals. The yellow mineral contains up to 5 per cent. of cadmium. In rare cases the surface of the mineral appears orange-colored with amorphous cadmium sulphide, which is otherwise known in tetrahedrons also greenokit. It is assumed that hydrogen sulphide must in some way have produced this sulphide, which is confined to the surface of the ores. The author also explained the cadmium distillation as practiced in Greece.

Valuable Books.

Engineers. The Practical Management of Engines and Boilers, including Boiler Setting, Pumps, Injectors, Feed Water Heaters, Steam Engine Economy, Condensers, Indicators, Slide Valves, Safety Valves, Governors, Steam Gages, Incrustation and Corrosion, etc. A Practical Guide for Engineers and Firemen and Steam Users generally. By William B. Le Van. 12mo, cloth, 257 pages. 49 illustrations.....$2 00

Explosive Materials. The Phenomena and Theories of Explosion and the Classification, Constitution, and Preparation of Explosives. By First Lieut. John P. Wisser. 16mo, boards, 160 pages. New York, 1898.....$0 50

Fats. Animal Fats and Oils: their Practical Production, Purification, and Uses for a great variety of purposes, their Properties, Falsification, and Examination. A Handbook for Manufacturers of Oil and Fat Products, Soap and Candle Makers, Agriculturists, Tanners, etc. By Louis Edgar Andés. With 62 illustrations. Translated by Charles Salter. 8vo, cloth, 240 pages. London, 1898. $4 00

Fuels. The Calorific Power of Fuels, Founded on Scheurer-Kestner's Pouvoir Calorifique des Combustibles, with the addition of a very full collection of Tables of Heats of Combustion of Fuels, Solid, Liquid, and Gaseous, to which is also appended the Report of the Committee on Boiler Tests of the American Society of Mechanical Engineers (December, 1897) and tables of constants used. By Herman Poole. 8vo, cloth, 255 pages. New York, 1898.....$3 00

Gas, Gasoline, and Oil Engines. By Gardner D. Hiscox. A book designed for the general information of every one interested in this new and popular motive power, and its adaptation to the increasing demand for a cheap and easily managed motor requiring no licensed engineer. Very fully illustrated, with folding plates. 8vo, cloth. New York.....$2 50

Glue. The Manufacture of Glue and Gelatine. The Application and Uses of Machinery, etc. Complete list of the Manufacturers and Dealers in the United States and Canada. 8vo, elegantly bound in leather, 223 pages. New York, 1898.....$10 00

Greenhouse Management. A Manual for Florists and Flower Lovers on the Forcing of Flowers, Vegetables and Fruits in Greenhouses, and the Propagation and Care of House Plants. By L. R. Taft. Illustrated, 12mo, cloth, 382 pages. New York, 1898. $1 50

Our large Catalogue of American and Foreign Scientific and Technical Books, embracing more than Fifty different subjects, and containing 116 pages, will be mailed, free, to any address in the world.

Any of the foregoing Books mailed, on receipt of price, to any address. Remit by Draft, Postal Note, Check, or Money Order, to order of

MUNN & CO.,
361 BROADWAY, NEW YORK.

Electricity Simplified.

By Prof. T. O'CONOR SLOANE.

158 Pages, Fully Illustrated. Price, $1.00.

THIS work is the simplest ever published on the subject of Electricity, and does something not hitherto accomplished. Electricity is in many respects unexplained by the scientists; to the ordinary man it is all a mystery. The object of "Electricity Simplified" is to make the subject as plain as possible, and to show what the modern conception of electricity is; to show how two plates of different metals immersed in acid can send a message around the globe; to explain how a hundred copper wire rotated by a steam engine can be the agent in lighting our streets; to tell what the volt, ohm and ampere are, and what high and low tension mean; and to answer the questions that perpetually arise in the mind in this age of electricity.

We can also furnish Prof. Sloane's works on electricity as follows:

Arithmetic of Electricity, 138 pages	**$1.00**
Electric Toy Making, 140 pages	**1.00**
How to Become a Successful Electrician, 189 pages	**1.00**
Standard Electrical Dictionary, 682 pages	**3.00**
Electricity Simplified, 158 pages	**1.00**

The above five volumes, comprising a **Complete Electrical Library,** sold at the *special reduced* price of **$5.00** put up in a neat folding box.

You save $2.00 by ordering the set complete. 5 volumes, 1,300 pages, over 450 illustrations.

☞ Send for special circular containing full table of contents of the above books.

JUST PUBLISHED.

Second Edition, Revised and much Enlarged.

Gas, Gasoline and Oil Engines

By GARDNER D. HISCOX, M.E.

The only American Book on the Subject.

THIS is a book designed for the general information of every one interested in this new and popular motive power, and its adaptation to the increasing demand for a cheap and easily managed motor requiring no licensed engineer.

The book treats of the theory and practice of Gas, Gasoline and Oil Engines, as designed and manufactured in the United States. It also contains chapters on Horseless Vehicles, Electric Lighting, Marine Propulsion, etc. Second Edition. Illustrated by 270 engravings. Revised and enlarged.

LARGE OCTAVO. 365 PAGES. PRICE $2.50.

CONTENTS.

Chapter I.—Introductory. Historical. Chapter II.—Theory of the Gas and Gasoline Engine. Chapter III.—Utilization of Heat and Efficiency in Gas Engines. Chapter IV.—Heat Efficiencies. Chapter V.—Retarded Combustion and Wall Cooling. Chapter VI.—Causes of Loss and Inefficiency in Explosive Motors. Chapter VII.—Economy of the Gas Engine for Electric Lighting. Chapter VIII.—The Material of Power in Explosive Engines, Gas, Petroleum Products and Acetylene Gas. Chapter IX.—Carbureters and Vapor Gas for Explosive Motors. Chapter X.—Cylinder Capacity of Gas and Gasoline Engines, Mufflers on Gas Engines. Chapter XI.—Governors and Valve Gear. Chapter XII.—Igniters and Exploders, Hot Tube and Electric. Chapter XIII.—Cylinder Lubrication. Chapter XIV.—On the Management of Explosive Motors. Chapter XV.—The Measurement of Power by Prony Brakes, Dynamometers and Indicators, The Measurement of Speed. The Indicator and its Work, Vibrations of Buildings and Floors by the Running of Explosive Motors. Chapter XVI.—Explosive Engine Testing. Chapter XVII.—Various Types of Gas and Oil Engines. Marine and Vehicle Motors.—Chapter XVIII.—Various Types of Gas and Oil Engines, Marine and Vehicle Motors—Continued. Chapter XIX.—United States Patents on Gas, Gasoline and Oil Engines and their Adjuncts—1875 to 1897 inclusive—List of the Manufacturers of Gas, Gasoline and Oil Engines in the United States, with their addresses.

A Few Extracts of Notices from the Press.

It is a very comprehensive and thoroughly up-to-date work.—*American Machinist.*

The subjects treated in this book are timely and interesting, as there is no doubt as to the increasing use of Gas, Gasoline and Oil Engines, particularly for small powers. It gives such general information on the construction, operation and care of these engines that should prove valuable to any one in need of such motors, as well as those already having them in use.—*Machinery.*

What an engineer says:

I beg to acknowledge receipt of your book on Gas, Gasoline and Oil Engines, by Hiscox, by registered mail. I am highly pleased with the book. It is the best on Oil Engines I have ever seen, is not intricate in the calculations, and the illustrations are excellent. Yours truly,

S. DALRYMPLE, Chief-engineer S. S. "Talune."
Melbourne, Victoria.

MUNN & CO. Publishers,
SCIENTIFIC AMERICAN OFFICE,
361 Broadway New York.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.

PAGE

I. CIVIL ENGINEERING.—The Portland Cement Industry of the World.—By BERNARD L. GREEN..... 19108

II. ELECTRICITY.—Lightning on the Kite Wire..... 19105
Telegraphy without Wires.—2 illustrations..... 19106

III. ETHNOLOGY.—Comparative American Civilization.—By HUBERT HOWE BANCROFT..... 19116

IV. HYDROGRAPHICS.—The Scope of Oceanography..... 19104

V. MECHANICAL ENGINEERING.—Smith's Tramway Chronograph.—2 illustrations..... 19107

VI. MEDICINE AND HYGIENE.—Inebriety and its "Cures" Among the Ancients.—By WILLIAM L. BROWN..... 19113

VII. MISCELLANEOUS.—The Graphophone at Omdurman.—1 illustration..... 19105
Electrical Notes..... 19112
Miscellaneous Notes..... 19112
Selected Formulæ..... 19112

VIII. PSYCHOLOGY.—The Advance of Psychology..... 19116

IX. SCIENCE.—Opening Address before the British Association by Prof. W. F. R. WELDON, M.A., F.R.S., President of Section D.—3 illustrations..... 19114

X. TECHNOLOGY.—Rubber Varnish.—By RALPH W. GRAY..... 19107
The German Blacksmith's Art.—8 illustrations..... 19110

XI. TRAVEL AND EXPLORATION.—Emperor William II. in the Uniform Designed for His Journey to Palestine.—1 illustration.. 19104

XII. WARFARE.—The Uniform of the French Army.—7 illustrations..... 19104

SPECIAL NAVAL SUPPLEMENT, No. 1165,

contains a historical review of the modern United States navy, the classification of the various forms of war vessels and nearly one hundred illustrations, including details of construction of such vessels not found in any other publication. A map of Cuba printed in five colors accompanies it. Price, 25 cents. Single copies sent by mail in United States, Canada and Mexico. Foreign countries, 8 cents extra.

MUNN & CO., 361 Broadway, New York.

THE SCIENTIFIC AMERICAN

Army and Coast Defence Supplement

GUNS, ARMOR AND FORTIFICATIONS.

The present number is uniform in size with our Special Navy Supplement, which has attracted such wide attention. It treats of guns and gun carriages for Army and Navy use and Coast Defence, including disappearing gun carriages, rapid fire guns, machine guns, mortars, etc., with special reference to their construction and operation. This section of the paper is profusely illustrated with drawings which enable their operation to be readily understood by the lay reader. The subject of projectiles, powders, gun cotton, etc., is also fully treated; range finders, torpedoes, submarine mines and armor are all fully described and illustrated. There is also a section devoted to the small arms of the Army and Navy, together with an account of the organization of the Army, with fine engravings of prominent Generals. Never before have these subjects been treated in such a popular way. The illustrations number over 100 and include a magnificent double page Supplement of our largest battleship, the "Iowa." The whole is enclosed in a handsome cover, showing a large coast defence gun in action.

Price by mail, 25 cents; to foreign countries, 35 cents.

MUNN & CO., Publishers, 361 Broadway, New York.

BUILDING EDITION

OF THE

SCIENTIFIC AMERICAN.

Those who contemplate building should not fail to subscribe.

ONLY $2.50 A YEAR.

Semi-annual bound volumes $2.00 each, yearly bound volumes $3.50 each, prepaid by mail.

Each number contains elevations and plans of a variety of country houses; also a handsome

COLORED PLATE.

SINGLE COPIES, - - - - - 25 CENTS EACH.

MUNN & CO., 361 Broadway, New York.

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had *fifty years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Trade Marks, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge, on application containing full information about Patents and how to procure them; directions concerning Trade Marks, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases, Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York

BRANCH OFFICES.—No. 625 F Street, Washington, D. C.

PAGE
... 19108
... 19105
... 19106
... 19116
... 19104
... 19107
... 19113
... 19105
... 19112
... 19112
... 19112
... 19116
... 19114
... 19107
... 19110
... 19104
... 19104